POWER

Vol. 39 NEW YORK, MARCH 10, 1914 No. 10

Self-Interviews

"But you know it's your own fault, Bill," said Bill Isolated-Plant Engineer. "That central-station fellow sized you up in no time that day he called 'just to look things over.' He saw you kept no records, that you were not as careful as you should be about buying coal. But when he saw that you were blowing hot condensate and steam to the sewer, and later, in the manager's office, compared the coal bills with what he judged to be the plant's average output, he knew you were easy."

"Now he's agreed to operate the plant on his company's current for less than you're furnishing it, and it's dollars to doughnuts the manager will sign."

"'Tain't fair," replied Bill Isolated-Plant Engineer, "if the manager was any good he'd hold off until I made a few test runs and gathered some data. But no, he's fallin' for this silver-tongued chap without giving me a chance."

"Wrong again, Bill," admonished William. "You've had a chance that was six years long. Things were going so easy like, you got to believe the job would last forever. You kept no records or check on the plant's performance. Book and cost keepin' wasn't your job."

"Now this fellow comes, looks around a while and tells the boss he's losin' money and losin' it fast, and shows pages of data to prove it."

"But I tell you we're not losin' money! The plant never ran better," pleaded Bill.

"I don't doubt it. But the fellow backs his statements with comparative figures. You deny him but offer nothing stronger than denials and angry protests. What do you expect the boss to do when you can't produce the figures he calls for?"

"Bill, you've been caught napping and you awoke too late to save this job. Remember, that fellow will visit your next plant; get to the boss with records and data before he does and show him that you can beat him at his own game."

[*Suggested by "Intimate Interviews" in "Life."*]

Remodeled Railway, Electric and Ice-Making Plant at Hampton, Va.

By Warren O. Rogers

SYNOPSIS—Reconstructing an antiquated central station into a modern installation, housed in the old building. Turbine generators have displaced reciprocating units, new pipe lines have been put in and a new coal-conveying system is operated by one man, whereas six were formerly employed. The inefficient ice-making plant has been brought up to full capacity.

When a central steam-power plant has become obsolete and is still kept in use, it indicates that the management is not alive to modern economical plant operation, and is endeavoring to supply customers with electrical energy from machinery that is inefficient and often inadequate to give satisfactory service.

An example of remodeling an old steam plant is that of the Newport News & Hampton Railway, Gas & Electric Co., Hampton, Va. This was done without interrupting the service, and is a work of credit to the engineers, Allen & Peck, Syracuse, N. Y.

The original equipment, installed in 1900, consisted of one 150-kw., 10,000-volt, three-phase, vertical turbine; one 750-kw., 3450-volt, engine-driven generator, a 500-kw., 500-volt., direct-current, engine-driven set, two 325-kw., 500-volt, engine-driven units and one 800-kw., 3450-volt engine-driven generator. There was also a miscellaneous collection of exciters, transformers, condensers and other power-plant apparatus.

Present Plant

As the plant now stands, the equipment is most modern. The turbine room is made with a basement and balcony across both ends and along one side, from end to end. A general view is shown in Fig. 1. At the far end of the room, level with the balcony floor, is the 1800-kw. vertical turbine, the only unit taken over from the old plant. This generator was originally wound for 1500 kw. capacity, at 10,000 volts, but was rewound for 3450 volts, to work in parallel with the two 2000-kw., horizontal units. These three units generate three-phase, 60-cycle, 3450-volt current. The horizontal units (Fig. 1) are at the side and at the opposite end of the room from the vertical turbine.

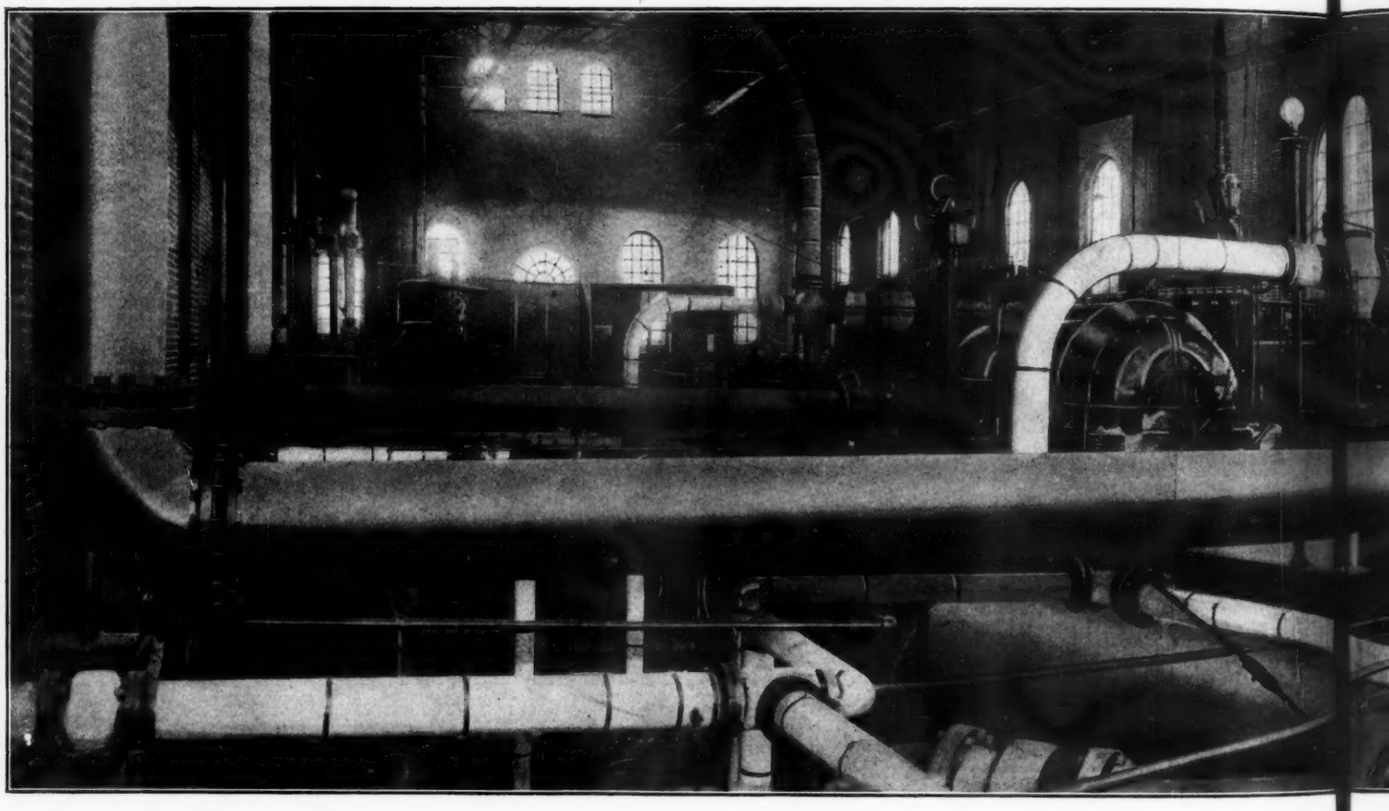


Fig. 1. General View of the Turbine Room of the Newport

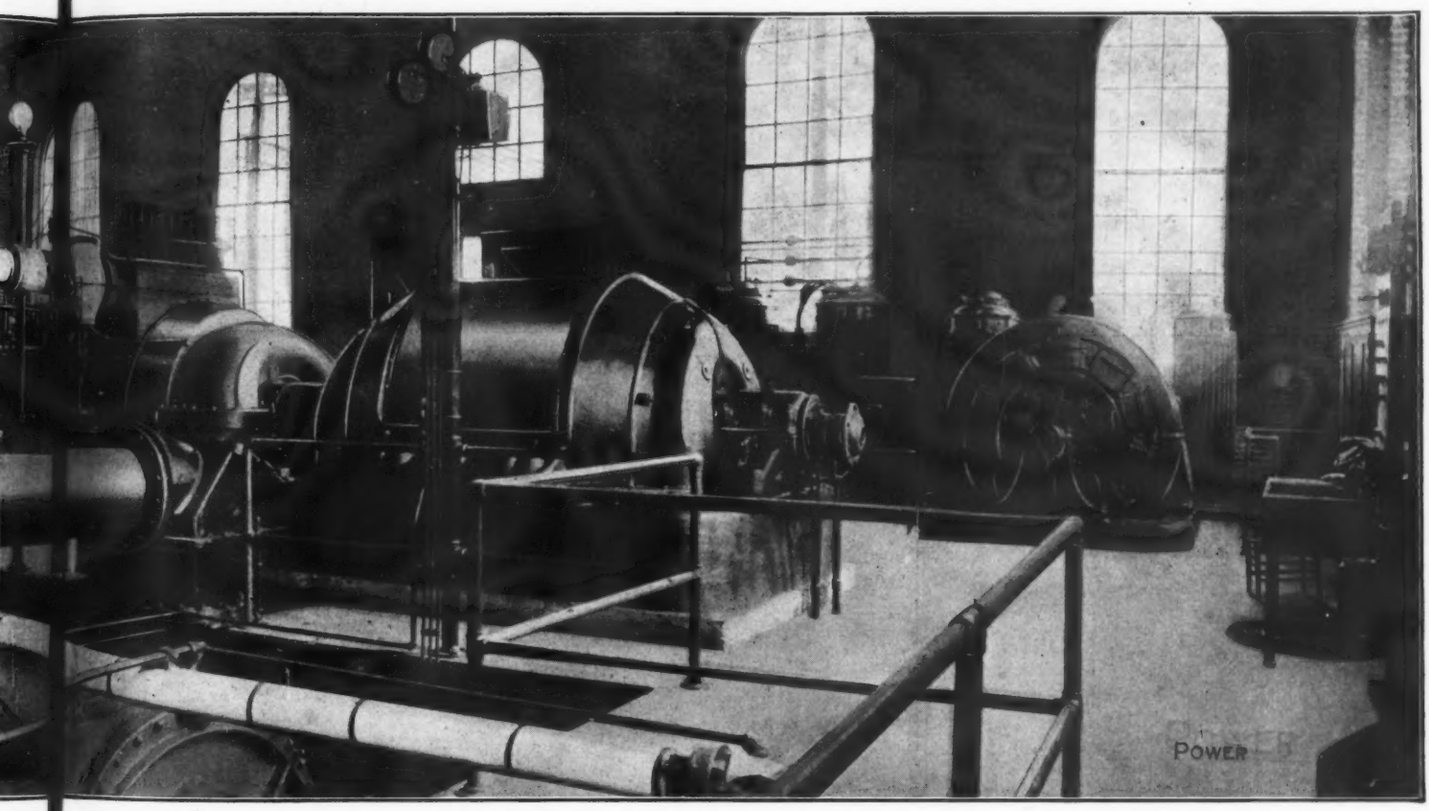
All condensing equipment is in the basement. That for the vertical turbine consists of a surface condenser and a turbine-driven circulating pump, a reduction gear being used between the circulating pump and the turbine. There is also an 8 and 18 by 12-in. air pump working at 105 r.p.m. These units are shown in Fig. 2. The step bearing is supplied with water by a 9 and 2 by 12-in., outside-packed, duplex pump at 400 lb. pressure. There are also two 6 and 2½ by 6-in. pot-valve pumps for emergency use.

At the opposite end of the turbine room are two 2000-kw. turbine units, generating 3450-volt, three-phase, 60-

cycle current, at 3600 r.p.m. Each unit exhausts into a separate surface condenser, of 6000 sq.ft. of cooling surface, or 3 sq.ft. of cooling surface per turbine kilowatt.

Air for cooling the turbine generators is supplied and discharged through two parallel air ducts, 9 ft. high and 4 ft. wide, running lengthwise of the basement. These ducts separate the electrical equipment in the basement from the steam auxiliaries. The air supply is controlled by a damper for each machine.

The condensers for the horizontal turbine are shown in Fig. 3, resting on concrete blocks at each end. This setting gives easy access to the condenser heads and to the piping. The two 15-in. circulating pumps are each driven by a 45-hp., side-crank engine. There are also two 8 and 18 by 12-in. air pumps, each piped to one condenser. These units are between the condensers and the side wall of the basement. A view of the 2000-kw. turbines and the opening above the condenser basement is shown in Figs. 1 and 4.



News & Hampton Railway Power Plant

Operating Troubles

With the old equipment, interruptions of service were frequent, due largely to loss of circulating water during low-tide periods. The condensing salt water was taken from a creek at a point at the rear of the power plant. This trouble was found to be due to the poorly constructed wooden intakes and to the two suction lines, 200 and 300 ft. long respectively. The intakes were of insufficient depth and were fitted with fixed screens which made cleaning difficult. This trouble has been eliminated by the construction of a concrete intake with the bottom 5 ft. below extreme low tide. It is equipped with double removable screens, having an area of four times that of the intake tunnel. The intake tunnel is 4 ft. wide and 8 ft. deep, and so constructed that the water flows to a point below the circulating pumps by gravity; at extreme low tide the tunnel contains 4 ft. of water at these points. The discharge tunnel, of the same size as the intake, is pitched so that the water discharges to the creek by gravity.

With the old condenser, containing $\frac{5}{8}$-in. tubes, trouble was experienced with floating débris, fish and sea growths. In the new equipment 1-in. condenser tubes are used. Provision has also been made for flushing the condenser tubes by reversing the flow of circulating water.

At times a combination of low tide and westerly wind tends to empty the creek. To provide against this, a 42-in. valve is placed between each condenser and turbine to permit of operating noncondensing. The atmospheric exhaust pipes are run across the condenser pit, as shown in Fig. 1, and pass through the roof.

Antiquated pipe construction encumbered the old boiler room, and most of the steam lines were run in duplicate from a double steam header back of the boilers, all in positions difficult to get at. The steam loss in the pipe lines and old equipment was so great that just previous to installing the new pipe lines an additional 500-hp. boiler was required.

The new steam header is erected in the turbine room, Fig. 5. Below it is a steel gallery which brings every valve and fitting in the header within reach for repairs, etc. The header, of 12-in. pipe in the center, reduces to 8 in. at the far end of the room and to 6 in. at the opposite end. It is made up of cast-steel fittings and van-stone joints, in anticipation of the use of superheated

FIG. 2. THE 18,000-KW. VERTICAL TURBINE AND CONDENSING APPARATUS. FIG 3. SURFACE CONDENSER EQUIPMENT IN THE BASEMENT. FIG. 4. LOOKING TOWARD THE 2000-KW. TURBINE. FIG. 5. STEAM HEADER AND BRANCH PIPING. FIG. 6. BOILER ROOM AND MOTOR-OPERATED COAL BARNEY. FIG. 7. LOCOMOTIVE CRANE, COAL-CRUSHING HOUSE AND 500-TON OUTSIDE STORAGE BIN

steam, and is supported at six points by brackets attached to the wall. The header is supplied with steam through 6-in. pipes from the boiler. A steam line for the auxiliary units in the basement connects to the bottom of the header and drops to the basement.

In the old plant the boiler-feed pumps were in the basement of the boiler room. They have been replaced by two turbine-driven centrifugal pumps placed in the turbine room. They run at constant speed and the supply of feed water for the boilers is regulated by a valve in each brass boiler-feed pipe. It has been found that with all feed valves closed the increase in pressure in the feed line is but 5 per cent.

Fresh water, from the city main, is used for cooling step bearings, etc. To economize, all clean, fresh water is elevated from a sump by either of two motor-driven centrifugal pumps to a tank above an open heater and is automatically fed to the heater as makeup water. In case of insufficient makeup water, city water is automatically fed to the tank.

Air for blowing out armatures, operating boiler-tube cleaners and handling ice, etc., is supplied by one of two vertical 11 and 11 by 12-in. air pumps which are secured to a frame made of I-beams and fastened to the wall. This allows for cleaning about the pumps and for free access for repairs.

Auxiliary Apparatus

On the turbine floor, between the 2000-kw. units and the side wall, are two rotary converters for 600-volt street-railway work. About midway of the turbine room are three exciter sets, each of 125 volts. One 50-kw. set is driven by a 75-hp. induction motor at 1165 r.p.m. The other two 125-volt generators are driven by 25- and 35-kw. turbines at 3600 r.p.m. each. The exhaust steam from the turbines is used for heating boiler-feed water.

At the end of the 11-panel slate switchboard are three 750-kv.-a., 60-cycle, three-phase, transformers which step up the current from 3450 to 10,000 volts at which it is transmitted to Newport News, and then transformed for local use. There is also a 15-kw., constant-current transformer for arc-light circuits. Six 165-kv.-a. oil-cooled transformers are used for motor circuits.

Boiler Room

The nine water-tube boilers consist of one 500-, two 400- and six 250-hp. capacity, Fig. 6, under 150 lb. pressure. Before the alterations the boilers were supported by steel I-beams which rested on I-beam girders, exposed to the corrosive action of moisture and gases from the ashes. Brick and concrete-floor arches were built in between the floor beams which had deteriorated so badly that the weight of the boilers had caused some of them to sag 1 in. in the center. These beams were reinforced by placing new ones under the old and all were then encased in concrete.

As a matter of economy and to assist in case of failure of the city water, the boiler-blowoff water is blown into a concrete tank 40 ft. long, 11 ft. wide and 4 ft. deep, divided at the center by a charcoal filter. One end of the tank receives the blowoff water and is fitted with a baffled vent to the atmosphere. The water passes through the filter to the other end of the tank, flows by gravity to the station sump and is then pumped to the feed-water heater and back to the boilers. Fig. 8 is a plan and Fig. 9 an elevation of the turbine room. The dotted lines indicate future equipment.

Coal- and Ash-Handling Equipment

Coal is delivered in 500-ton barge loads at the docks, Fig. 7. The new coal-handling equipment has a capacity of 50 tons per hour, and is operated by one man. The old equipment had a capacity of 10 tons per hour and required six men to operate it. There was no outside storage capacity. With the new equipment, the coal is delivered to the crushing rolls and scale by a steam locomotive crane and is then conveyed to the outside 500-ton steel-suspended bunker by a belt conveyor. From the outside bunker the coal is delivered to the boiler stokers by a motor-operated two-ton barney which runs on a track above the stokers, as shown in Fig. 6. The outside storage of 2000 tons is necessary as the design of the boiler house does not permit of sufficient space for an overhead bunker.

Ashes are loaded from the stoker ash hoppers into a standard-gage flat car in the basement, and are hauled away by a trolley locomotive. This eliminates handling the ashes before unloading the car.

Ice Plant

In connection with and adjacent to the power plant is a 100-ton ice plant, containing one 40-ton and one 60-

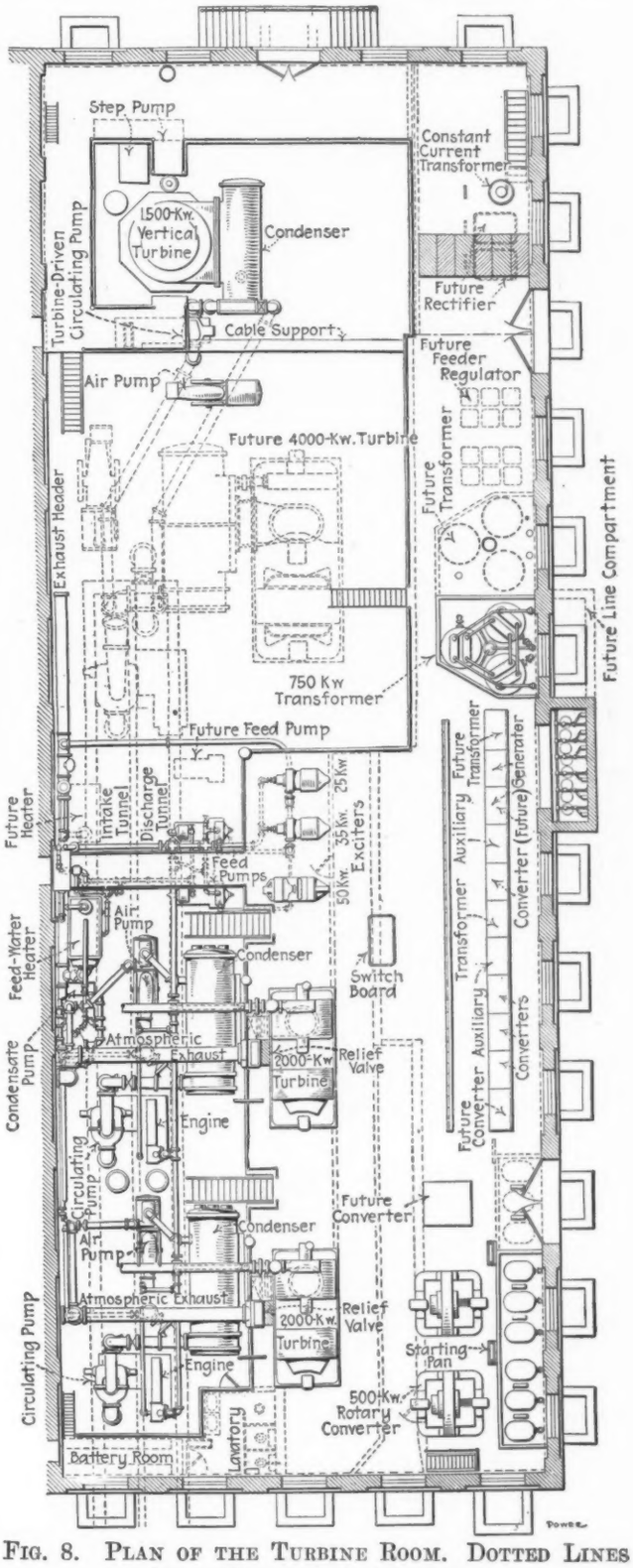


Fig. 8. Plan of the Turbine Room. Dotted Lines Show Future Installations

ton capacity ammonia compressor. The small unit has 14x28-in. and the other 16x24-in. tandem-compound condensing cylinders, Fig. 10.

The ice plant was as badly worn out as the power plant. The freezing tank of the 40-ton machine had been discarded, and because of inadequate auxiliary facilities both compressors were operated on the 60-ton tank during hot weather and then failed to obtain its full capacity. Since the plant has been overhauled an average output of 105 tons of ice per day can be maintained, and in addition a storeroom is refrigerated.

Atmospheric ammonia condensers are used. The stands

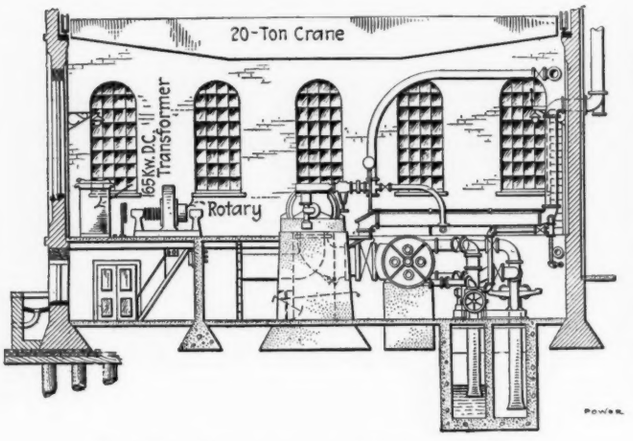


FIG. 9. ELEVATION OF TURBINE ROOM

are 20 ft. long, made up of 2-in. pipes, 12 pipes high. There are five stands for the 40-in. machine and seven for the 60-ton unit. Approximately 60 gal. of water per min. are required for each stand.

The coolers are made of galvanized-iron, standard-weight pipe, and 30 gal. of water are used per min. per stand.

The freezing tank for the 40-ton unit contains 12,480 ft. of 1¼-in. pipe and 596 cans, each of 300-lb. capacity. This tank is operated as a wet-gas system, a 30-in. by 8-ft. accumulator being set in the tank.

The 60-ton tank contains 12,036 ft. of 1¼-in. pipe and 720 ice cans, each of 300-lb. capacity. This has been changed to a wet system by the addition of two 20-in. by 8-ft. accumulators.

The new handling rooms for the small and large compressors are of 450 and 750 sq.ft. respectively. They, with two storage rooms of 680 tons capacity, are refrigerated by direct expansion. The storage tanks are cooled by direct expansion instead of passing the return gas from the freezing tank through the coils.

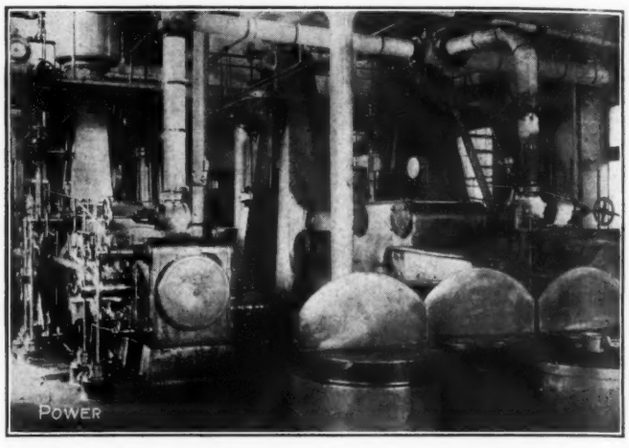


FIG. 10. PARTIAL VIEW OF THE 40- AND 60-TON AMMONIA COMPRESSORS

PRINCIPAL EQUIPMENT OF NEWPORT NEWS AND OLD POINT COMFORT RAILWAY AND ELECTRIC CO.'S POWER PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
1	Turbine	Curtis, vertical	1800 kw.	Main generator	900 r.p.m. 150 lb., sat. steam, condensing	General Electric Co.
2	Turbines	Curtis, horizontal	2000 kw.	Main generators	3600 r.p.m., 150 lb., sat. steam, condensing	General Electric Co.
1	Turbine	Terry		Circulating pump	150 lb. steam, 2500 r.p.m., non-condensing	Terry Steam Turbine Co.
2	Turbines	Alberger		Boiler feed pumps	Non-condensing, 150 lb. steam	Alberger Pump & Condenser Co.
1	Turbine	Curtis	35 kw.	Driving exciter	3600 r.p.m., 150 lb. steam, non-condensing	General Electric Co.
1	Turbine	Curtis	25 kw.	Driving exciter	3600 r.p.m., 150 lb. steam, non-condensing	General Electric Co.
2	Engines	Horizontal side crank	8x10"	Circulating pumps	Variable speed	Ridgeway Dynamo & Engine Co.
2	Generators	Alt. current	2000 kw.	Main generators	3600 r.p.m., three-phase, 60-cycle, 3450 volt	General Electric Co.
1	Generator	Alt. current	1800 kw.	Main generator	900 r.p.m., three-phase, 60-cycle, 3450 volt	General Electric Co.
1	Generator	Direct current	50 kw.	Exciter	1165 r.p.m., 125 volt	General Electric Co.
1	Generator	Direct current	35 kw.	Exciter	3600 r.p.m., 125 volt	General Electric Co.
1	Generator	Direct current	25 kw.	Exciter	3600 r.p.m., 125 volt	General Electric Co.
2	Motors	Induction	3 hp.	Make-up pump	1800 r.p.m., 220 volt, three-phase, 60 cycles	General Electric Co.
1	Motor	Induction	75 hp.	Driving exciter gen.	1165 r.p.m., three-phase, 60 cycle	General Electric Co.
1	Pump	Centrifugal	14"	1800 kw. unit circ. water		Platt Iron Works Co.
1	Pump	Reciprocating	8x18x12"	1800 kw. unit condenser, air	150 lb. steam, 105 r.p.m.	C. H. Wheeler Mfg. Co.
1	Pump	Outside racked	9x2x12"	Step bearing	400 lb. pressure	Henry R. Worthington
2	Pumps	Pot valve, duplex	6x2½x6"	Step bearing	400 lb. pressure	Henry R. Worthington
2	Pumps	Centrifugal	15"	Circ. water	Engine driven	C. H. Wheeler Mfg. Co.
2	Pumps	Mullen, air	8x18x12"	Surface condensers	150 lb. steam, 29" vac.	C. H. Wheeler Mfg. Co.
2	Pumps	Five stage	2½"	Boiler feed	Continuous	Alberger Pump & Condneser Co.
2	Pumps	Centrifugal		Make-up water	Motor driven, 1800 r.p.m.	C. H. Wheeler Mfg. Co.
1	Condenser	Surface	6M. sq.ft. cooling surface	1800 kw. vertical unit	29" vacuum	C. H. Wheeler Mfg. Co.
2	Condensers	Surface	6M. sq.ft. cooling surface	2000 kw. units	29" vacuum	C. H. Wheeler Mfg. Co.
1	Reducing gear	Folk		Between turbine and cir. pump		Foote Bros. Gear & Mch. Co.
1	Heater	Open Cochrane		Feed water	Exhaust steam	Harrison Safety Boiler Works
1	Transformer	Constant current	15 kw.	Arc lighting	Primary 3120 volt, 6.6 amp.	General Electric Co.
3	Transformers	Three phase	750 kv.a.	Power and lighting	3450 to 10,000 volts, 60 cycle	General Electric Co.
6	Transformers	Oil cooled	165 kv.a.	Motor circuits	3450 to 430 volts	General Electric Co.
1	Boiler	Water tube	500 hp.	Steam generators	150 lb. pressure, hand fired	Heine Safety Boiler Co.
2	Boilers	Water tube	400 hp.	Steam generators	150 lb. pressure, mechanical stokers	Babcock & Wilcox Co.
6	Boilers	Water tube	250 hp.	Steam generators	150 lb. pressure, mechanical stokers	Babcock & Wilcox Co.
8	Stokers	Murphy		Boiler furnace	Mechanical	Murphy Iron Works
1	Conveyor	Belt		Conveying coal	Intermittent, motor driven	Exeter Machine Co.
1	Crane	Locomotive	10 ton	Conveying coal	Intermittent, steam driven	Brown Hoisting Machinery Co.
1	Compressor	Ammonia	40 ton	Ice plant	Steam driven, tandem comp., cond.	Frick Co.
1	Compressor	Ammonia	60 ton	Ice plant	Steam driven, tandem comp., cond.	York Mfg. Co.

Legal Aspects of Boiler Explosions

By A. L. H. Street

SYNOPSIS—Liability for injury to person or property is tested by failure to use that degree of care exercised by an ordinarily prudent person. Responsibility of insurers, manufacturers and employees. Appellate court decisions on the subject reviewed.

Legal liability in damages for injury to person or property, resulting from explosion of a boiler, must, according to repeated decisions of the courts, rest upon failure to use that degree of care to avoid an explosion that a person of ordinary prudence would use in the same or similar circumstances.

For the purpose of applying this principle, the negligence of an employee must be attributed to his employer, rendering the latter responsible for any injury resulting to a third person (West Virginia Supreme Court of Appeals, 41 Southeastern Reporter 187).

But a presumption of negligence does not arise from the mere explosion of a boiler used in a lawful business; negligence attributable to the person in control of it must be affirmatively shown. Announcing this principle in the case just cited, the West Virginia court pointed out that the American courts follow a different rule from that applied by the English bench. In England an owner of land is *prima facie* liable for injury caused by any dangerous instrumentality which he may have constructed thereon. "But such is not the American law. That law says that the English rule detracts from the efficiency of that ownership, cripples a plain right of ownership, and makes that owner an insurer against harm to others resulting from mere accident in the lawful use of his property."

This same rule has been applied by the Colorado courts, in holding that the fact that a boiler exploded, injuring an adjoining building, created no presumption of negligence on the owner's part, in the absence of a showing that the boiler was defectively constructed or improperly maintained (61 Pacific Reporter 50). But the Michigan Supreme Court has held that proof that a boiler exploded when subjected to a steam pressure of 80 lb., with the safety valve set to blow off at 90 lb., established *prima facie* negligence on the part of the owner, where it appeared that the boiler was safe only under a pressure of 60 lb. or less (87 Northwestern Reporter 793).

In a Rhode Island case, it was decided by the supreme court that one who sued for personal injury, caused by a boiler explosion, made out a *prima facie* case of negligence in subjecting the boiler to an extraordinary pressure, by showing that it burst when apparently in good condition and capable of withstanding ordinary pressure (69 Atlantic Reporter 69). But if the cause of an explosion cannot be definitely ascertained and if the circumstances shown to have existed are just as consistent with a cause for which the owner of the boiler is not responsible as with a cause for which he would be responsible, there can be no recovery; damages will not be awarded upon a conjecture as to the real cause of the accident (Kentucky Court of Appeals, 48 Southwestern Reporter 434). In a Michigan case, wherein the plaintiff claimed that bursting of a boiler resulted from defendant's failure to properly inspect it, the supreme court held that it was open to defendant to show that it was not practicable to remove the flues to ascertain the condition of the braces which the plaintiff claimed were defective (91 Northwestern Reporter 647). But it is to be noted that, ordinarily, an owner of a boiler is just as much responsible for failure to discover a defective condition existing in it, as he is for omitting to repair a defect known to him (Michigan Supreme Court, 99 Northwestern Reporter 27).

Evidence of precautions taken by the owner, *after* an explosion, to avoid recurrence of a similar accident, cannot be shown in evidence as an implied admission of negligence in the manner in which the exploding boiler was maintained (Pennsylvania Supreme Court, 51 Atlantic Reporter 979). But in a suit for injury to a building caused by explosion of a boiler in an adjoining building, it was held by the Pennsylvania supreme court that it was no defense that the boiler had been inspected by a boiler-insurance company, in the absence of further proof that the inspectors were competent, and that they properly inspected the boiler and made a true report (56 Atlantic Reporter 345). The court decided that, in order to relieve defendant from liability, there must have been no evidence of want of care in selecting mechanics to make proper repairs, and that an inspection must be shown to have been made by competent persons after the repairs were made and before the explosion occurred.

The employee of a boiler owner, to whose negligence an accident is directly attributable, as well as the owner, may be held responsible to a third person who has been injured in person or property by the explosion complained of. The personal responsibility of an engineer for injury to another, resulting from an explosion due to an insufficient water supply, depends upon the inquiry whether he used that degree of care to keep the water at the proper point in the boiler which an ordinarily careful engineer would use in like circumstances (Connecticut Supreme Court of Errors, 85 Atlantic Reporter 380).

A boiler-insurance company may be held liable for injury to a third person caused by bursting of an insured boiler, if the company coöperated actively with the owner of the boiler in its management, so far as the injury is attributable to the company's failure to use a proper degree of care and skill (19 Atlantic Reporter 472). The decision in this case is authority for stating that all persons, whether owner, employee or volunteer, are responsible for injury resulting from mismanagement of a boiler. But, in another case, a United States circuit court held that another boiler-insurance company, not being an insurer as regards a third person, was not responsible for his death, resulting from explosion of an insured boiler, even though the company certified that the boiler had a higher degree of strength than was the fact, unless the so doing was the result of negligence (19 Federal Reporter 246).

And, although a buyer of a boiler is entitled to recover from the manufacturer damages caused by an explosion resulting from defective construction (156 Pennsylvania Supreme Court Reports 156), the manufacturer is liable

to the buyer only for any defects, and not to a third person who may be injured on account thereof (51 New York Reports 494).

As to injuries to employees, it is generally held by the courts that their employers must use reasonable care to see that their places of work are reasonably safe. It is to be noted that the duty is not an absolute obligation to keep the places absolutely, or even reasonably, safe. Therefore, the liability of an employer for injury to an employee resulting from bursting of a boiler is tested by the question whether the employer has used a reasonable degree of care to see that the boiler was reasonably safe. Cases involving injury to workmen, however, are often taken outside the principles applicable to outsiders, as above outlined, by reason of the arising of questions of assumption of risk, contributory negligence, and negligence of co-employees. Thus, notwithstanding the fact that an employer may have permitted a boiler to remain in an unsafe condition, there is no liability, under the general rules of law as applied by the courts, if the employee voluntarily encountered the risk of an explosion when an ordinarily prudent employee would not have done so, or if he failed to perform any duty resting upon him to make an inspection for his own safety, or if the explosion resulted from negligence of a co-employee in a state where the "fellow servant doctrine" is in force.

Cost of Operating a Gas-Producer Plant

By F. J. Rode

The power plant of the A. O. Smith Co., Milwaukee, has two 400-kw. Allis-Chalmers gas-engine units, one installed in 1910, and the other in 1911. The first was served by two 400-hp. Wood producers and the second unit by two Smith producers of 350 hp. each. The entire plant up to this time had been operated on hard coal of both buckwheat and pea sizes. In 1912, however, when hard-coal prices rose from $4 to $6 per ton in this vicinity, it was decided to operate the entire plant on soft coal.

First, Illinois coal was considered, as this could be delivered for $2.90 per ton at the plant; but after experimental operation on different kinds of coal, including West Virginia splint, Indiana, Illinois and Hocking Valley coals, Hocking Valley nut coal was found to deliver the largest number of kilowatt-hours for one dollar. The heat value per cubic foot of this gas averaged 160 B.t.u., and Sunday Creek Hocking showed as low as 1.5 lb. per kw.-hr., although the average for 1913 was near 2 lb.

A saving in the cost of operation of 0.3c. per kw.-hr. was effected by changing to soft coal. The price of coal varied during 1913, but at present the coal is delivered to the producers at $3.50 per ton. The change from hard coal to soft coal required a few changes in the Smith producer equipment, Smith static tar extractors being installed. This was the second equipment of its kind up to that time, and it has been found reliable and effective.

The Wood producers were equipped with rotary tar extractors when first installed; hence no changes were required. The tar is burned under steam boilers, which are used for drop-forge and heating purposes. No credit is allowed the gas plant, for this tar, although 9½ lb. of water are evaporated per pound of tar.

The accumulation of tar varies somewhat with the volatile matter in the coal. The Hocking Valley coal now used runs from 80 to 100 lb. per ton in the Smith producers, and somewhat higher in the Wood producers.

Month	Hours of Running	Tons of Coal Consumed	Cost of Coal Consumed	Cost of Attendance	Cost of Supplies	Kw.-Hr. Output	Cost of Operation per Kw.-Hr., c.	Fixed Charges per Kw.-Hr.	Total Cost per Kw.-Hr.	Cost of Operation	Cost of Operating, Including Fixed Charges	Load Factor During Time of Operation
Jan.	568	267.7	$930.00	$767.75	$109.75	325,400	0.556	0.279	0.835	$1807.50	$2707.50	0.715
Feb.	500	241	903.75	810.40	96.22	284,230	0.636	0.321	0.957	1810.37	2710.37	0.71
Mar.	554	272	980.00	601.60	87.40	296,620	0.565	0.301	0.866	1669.00	2569.00	0.665
April	304	168.4	586.00	407.65	63.80	190,700	0.558	0.464	1.020	1057.45	1957.45	0.78
May	470	220	792.00	571.95	43.40	236,700	0.595	0.382	0.994	1407.35	2307.35	0.71
June	244	140	504.00	437.45	48.64	142,000	0.697	0.683	1.33	990.09	1890.09	0.73
July	235	185	660.00	405.45	43.10	134,000	0.825	0.660	1.485	1108.55	2008.55	0.715
Aug.	205	110	396.00	396.25	26.10	98,200	0.836	0.916	1.752	818.35	1718.35	0.60
Sept.	230	125	450.00	405.45	34.00	133,000	0.670	0.677	1.347	889.45	1789.45	0.712
Oct.	240	173.5	606.00	422.50	35.20	152,810	0.700	0.590	1.30	1063.70	1963.70	0.79
Nov.	215	163.5	590.00	396.55	32.30	144,990	0.705	0.620	1.325	1018.85	1918.85	0.837
Dec.	235	178	624.00	383.65	24.60	159,120	0.880	0.520	1.270	1032.25	1932.25	0.815
Total	4000	2244.1	$8021.75	$6006.65	$644.51	2,297,770				$14672.91	$25472.91	
Aver. per mo.	333.33	187	668.48	500.54	53.71	191,480	0.634	0.470	1.104	1222 74	2122.74	0.73

Cost of operating, 1913		$14,672.00
Cost of deprecation taxes, interest and insurance		10,800.00
Cost of operating per kw.-hr.	0.634c.	$25,472.00
Cost of fixed charges per kw.-hr.	0.470c.	
Total cost per kw.-hr.	1.104c.	

Waste water is used for scrubbing and no charge is made in the report for water.

The waste heat of the gas-engine exhaust is utilized, the boiler plant being supplied with jacket water pumped through gas-engine exhaust heaters; all excess water is sprayed and reused.

The plant represents an investment of $80,000, and the fixed charges are taken at 13.5 per cent., which amount to $10,800 per year, or $900 per month. The accompanying tabulation shows the operating and total costs for 1913, as well as the monthly load and load factor.

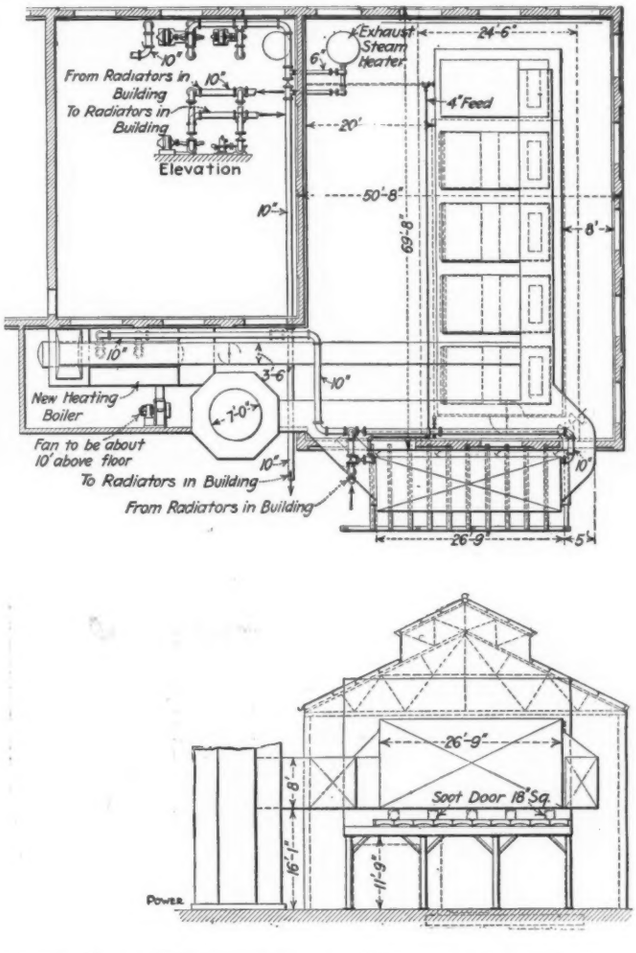
Repairs on the plant are included under "Cost of Supplies" and labor for such repairs in "Cost of Attendance."

Using an Economizer on a Hot-Water Heating System

By W. L. Durand

The use of an economizer for heating water for a forced hot-water system is sufficiently novel to warrant a brief description of a recent installation at the plant of the Farrel Foundry & Machine Co., Ansonia, Conn.

The original heating system was installed several years ago, and a live-steam heater and a 150-hp. water-tube heating boiler were used for heating the water. Because of rapidly increasing demand on the heating system, as new buildings were added, the boiler and heater were of insufficient capacity. Furthermore, the space



Position of Economizer and Pipe and Smoke Flue Connection

where the boiler was located was required for a steam boiler to take care of the increased load on the engines.

The power plant consists of 1600 hp. in water-tube boilers and an engine-low-pressure turbine plant. It was found that greater yearly economy was obtained by using the exhaust from the engines in a low-pressure condensing turbine than for heating the water for the heating system.

After examining several different plans, the final selection was made on the basis of the minimum total annual expense, although the first cost was the highest. The system has now been in satisfactory operation for the greater part of the present heating season. The leading features are as follows:

The 150-hp. heating boiler was scrapped to make room for a new steam boiler, and heating apparatus was installed, partly in the form of an economizer and partly as a heating boiler, and sufficient altogether to provide for 65,000 sq.ft. of radiation, which allows for all possible future expansion on the present property.

The flue gases left the boilers at from 500 to 600 deg. F. An economizer was installed to utilize the available heat, which was estimated to furnish about one-third of the total required for the system under maximum weather conditions. On this basis, moreover, the same estimate indicates a capacity sufficient to provide for 50 to 60 per cent. of the total average heat required throughout the heating season. These estimates indicate the economy which the use of the economizer may be expected to secure.

The economizer consists of 44 sections, each section 10 tubes wide and each tube 12 ft. long, making a total of 7200 sq.ft. of heating surface. The branch pipes were increased from 4 to 10 in. to accommodate the large volume of water that is to be handled. One 2½-in. safety valve was placed on each end of the economizer. It was found impossible to locate the economizer in the power house and it was, therefore, placed outside on structural-steel supports, as shown in the accompanying illustration. A house, of angle-iron frame and corrugated galvanized-iron covering, was built over the economizer to protect it from the weather. The roof is made in removable sections to permit of drawing tubes.

To provide the balance of the heating capacity, as required, a standard 285-hp. water-tube boiler, with longitudinal drum, was installed, so that in case it should ever be desired for power purposes, no changes would be necessary. The only special feature is a baffle-plate in the center, so arranged as to prevent the water from short-circuiting through the drum. This baffle-plate is made in sections and can be taken down and removed through the manhole if the boiler is to be used for power purposes. The water enters the rear of the drum and flows down the rear header, up through the tubes, up the front header and out at the front of the drum. Therefore, the flow of the water is in the same direction as the natural circulation in the boiler under steaming conditions.

Both economizer and boiler are provided with bypass connections, so that either one can be run without the other.

The dampers in the main smoke breeching and in the intake to the economizer are controlled by a thermostat located in the hot-water pipe leaving the economizer.

On account of the long run from the boiler to the main breeching, a balanced-draft system was installed to prevent the gases being blown out of the furnace door. The fan used is a centrifugal blower of the multi-vane type and is controlled by a thermostat located in the flow

pipe leaving the boiler. By the use of the two thermostats any desired temperature is maintained in the circulating water.

The water is circulated by a double-suction, 1500-gal. per min. centrifugal pump, directly connected to a motor. The present pump is kept in reserve for use in case of emergency. An interesting point may be mentioned in connection with the circulation of the water. Two methods of pumping have been tried with the system. First, pumping the water through the boiler and economizer or heater and then to the heating system. Second, connecting the suction side of the pump to the boiler and economizer and pumping direct to the heating system. It was found after trial that much better results were obtained with the latter method, which is the one now in use.

An added economy is gained in the use of the economizer by connecting it to the boiler-feed line so that during the summer when the economizer is not used for the heating system it can be used to heat the feed water. The feed water now enters the boiler at about 200 deg.; if it passes through the economizer it is raised to between 280 and 290 deg. F.

In operating an installation of this kind, care should be taken to always keep the pump going. If the economizer is to be cut out or the pump stopped, the dampers to the economizer should be fully closed and if possible the economizer emptied of water. If this is done no danger from an explosion need be feared.

This installation was designed by and installed under the direction of Clark, MacMullen & Riley, consulting engineers, New York City.

Some Results of Twenty-Four-Hour Plant Test

By B. R. T. Collins

SYNOPSIS—This test was made on the entire power equipment of the Goodyear Tire & Rubber Co., of Akron, Ohio. Besides determining the performance of the different machines the most economical rate of driving the boilers was found and the cost of electricity generated by the low-pressure turbo-generators was computed.

About three years ago the management of the Goodyear Tire & Rubber Co., of Akron, Ohio, decided upon making a thorough and systematic operating investigation of all of its power equipment at least once every year to supplement its daily and monthly records of operating data and power costs and to bring out clearly the progress made in reducing the cost of power. The last of these investigations was made during July, 1913, one of the most important features of the work being a 24-hr. complete plant test. Before and after this test, a large number of special investigations were made to supplement the results of the longer test and enable definite comparisons of the relative efficiencies of similar kinds of equipment to be made.

Among these tests were some on the Green L-type chain-grate stokers which are of special interest as they are the largest of this type yet placed in service. They are provided with inclined plates, located under the ignition arch and which break up any crust forming with a coking coal. There are six of these stokers installed under 822-hp. Stirling boilers.

The coal used was a mixture of Cambridge and Youghiogheny slack having 35.44 per cent. volatile combustible matter, 50.39 per cent. fixed carbon, 12.27 per cent. ash, 1.90 per cent. sulphur and a heat value of 13,572 B.t.u. per pound of dry coal.

The tests were made under ordinary working conditions, without special effort to obtain the highest efficiency, but to determine the capacity and efficiency with about one-half of the available natural chimney draft and with the full draft. The principal results were as follows:

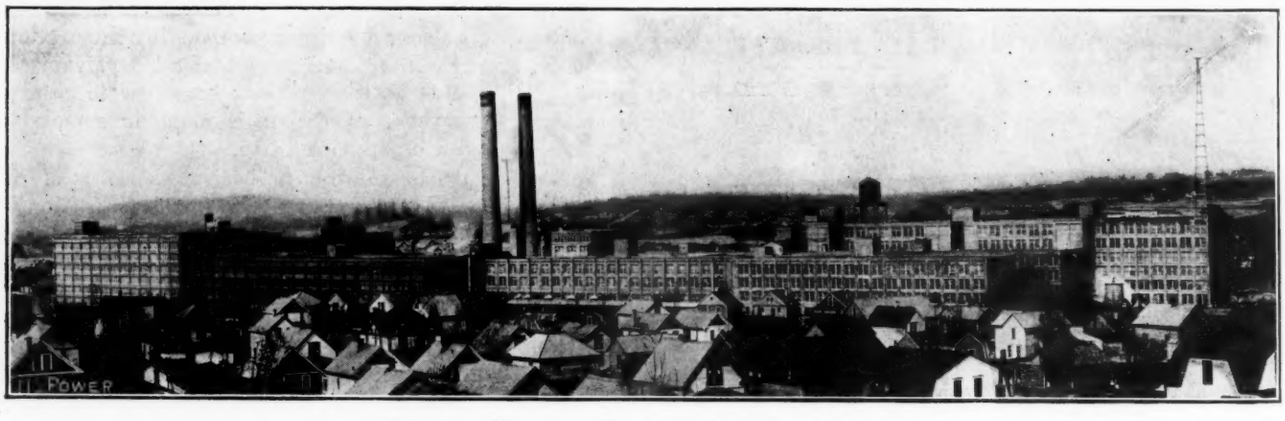


Fig. 1. General View of Goodyear Plant

TABLE I. DATA FROM DRAFT TESTS

	Half Draft	Full Draft
Duration of test, hr.	4	2
Horsepower developed	1418	1702
Percentage of rating developed	172.5	207.1
Dry coal burned per hr., lb.	4993	6351
Dry coal per hr. per sq.ft. of grate surface, lb.	27.4	34.9
Equivalent evaporation per sq.ft. of heating surface per hr., lb.	5.94	7.14
Steam pressure, lb. per sq.in.	166.7	170.8
Temperature of feed water entering boiler, deg. F.	213.8	214.0
Temperature escaping gases, deg. F.	647.6	668.1
Draft in furnace, in. of water	0.25	0.45
Draft in uptake, in. of water	1.04	1.25
Draft in stack, in. of water	1.60	1.60
Percentage of moisture in steam at boiler	1.7	1.6
Water evaporated per lb. of coal, actual conditions, lb.	9.21	8.68
Water evaporated per lb. of dry coal from and at 212 deg. F., lb.	9.80	9.25
Efficiency of boiler and grate, per cent.	69.5	69.0
Cost of coal to evaporate 1000 lb. of water from and at 212 deg. F.	$0.082	$0.087

As will be noted, the capacity with the full draft in the furnace of 0.45 in. of water as compared with 0.25 in. draft was 34.6 per cent. of the rating greater; the coal burned per square foot of grate surface per hour was greater by 7.5 lb., or 27.4 per cent.; the equivalent evaporation per square foot of heating surface per hour was greater by 1.2 lb., or 20.2 per cent.; the temperature of the flue gases was higher by 20.5 deg. F.; the equivalent evaporation was less by 0.55 lb., or 5.6 per cent.; the efficiency was less by 0.5 per cent. and the cost of coal to evaporate 1000 lb. of water was greater by $0.005, or 6.1 per cent.

The general conclusion reached was that it was not economical to run the stokers and boilers at the higher rating unless a shortage of boiler capacity required it; also in view of the high temperature of the flue gases, on both tests, it was decided to investigate the question of installing superheaters. Another reason for this investigation was the rapid wear on the blading of some of the small steam turbines, of which there are six in the plant.

Twenty-three men from the engineering, experimental and chemical departments of the company, working on two 12-hr. shifts, obtained the data required. This included records of the weights of coal burned under the boilers; weights of water pumped into the boilers as determined by the recording venturi meters; draft in furnaces, uptakes, and stack; flue-gas analyses in rotation from all of the boilers in service by means of an Orsat apparatus; calorimeter determinations of moisture in the steam at the boilers; temperature of flue gases and feed water at the heater and boilers; analyses of coal used and ash obtained; indicator cards from both the Fulton and Hamilton engines; steam pressure at throttles; receiver pressures; vacuums; temperatures of injection and discharge condensing water; temperatures of inside and outside air; barometer readings; pressure of hydraulic and compressed-air systems; electrical readings giving output of generators connected to Allis-Chalmers and Rateau turbines, as well as a record of the time of operation of all equipment in the factory using power. All readings were taken at 15-min. intervals during the entire 24 hr.

The principal data and results of the 24-hr. test on the boilers were as follows:

TABLE II. RESULTS OF 24-HR. TEST ON BOILERS

Number of boilers in service	5
Kind of Fuel—Cambridge and Youghiogheny Slack	
Percentage of ash and refuse	12.3
Fuel per hr. per sq.ft. of grate surface, lb.	25.1
Water evaporated per hr. per sq.ft. heating surface, lb.	5.00
Steam pressure, lb.	168
Temperature feed water entering boiler, deg. F.	213.7
Temperature of escaping gases, deg. F.	626.1
Draft in furnaces, in. of water	0.285
Percentage of moisture in steam at boiler	1.1
Horsepower developed	6201
Horsepower in service, builders' rating	4110
Percentage of builders' rating developed	150.9
Water evaporated per lb. of fuel, actual conditions, lb.	8.65
CO_2 in flue gases, per cent.	7.58
Oxygen in flue gases, per cent.	12.40
CO in flue gases, per cent.	0.014
Efficiency, per cent.	68.4
Cost of fuel to evaporate 1000 lb. of water from and at 212 deg. F.	$0.0861

Heat Balance	Btu.	Per Cent.
Heat absorbed by the boiler	10,310	68.4
Loss due to moisture in fuel	59.7	0.40
Loss due to moisture formed by burning of hydrogen	757	5.02
Loss due to heat carried away in chimney gases	3,732.5	24.75
Loss due to incomplete combustion of carbon	15.0	0.11
Loss due to radiation, unburned fuel and gases, etc.	205.8	1.32
Total heat of 1 lb. of combustible	15,081.0	100.00

Coal Analysis	Per Cent
Moisture	3.92
Volatile combustible matter	34.13
Fixed carbon	51.30
Ash	12.57
Sulphur	2.63
Heating value, B.t.u. per lb. dry coal	13,410

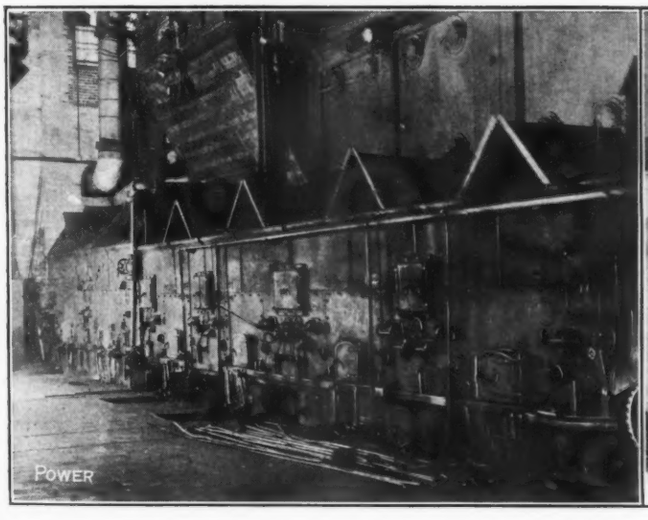


FIG. 2. STOKERS

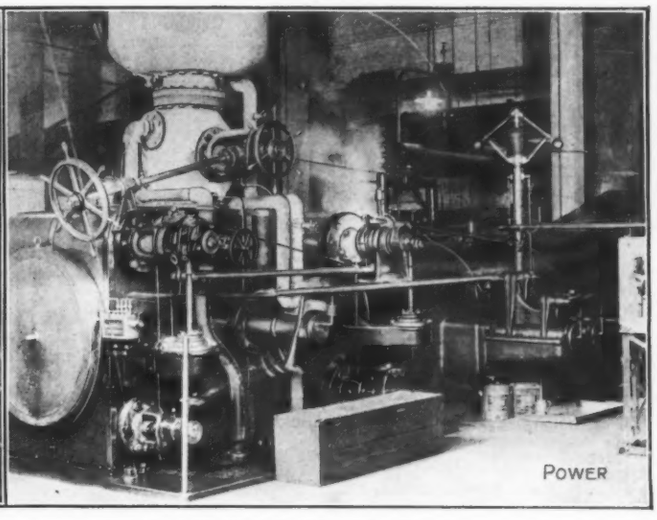


FIG. 3. 2500-HP. CORLISS ENGINE

It will be noted from these results that the average horsepower developed during the 24-hr. run was 6201, or 150.9 per cent. of the rating. This overload of about 50 per cent. has proved to be an economical point at which to run the boilers, as determined on tests made with boilers of similar capacity equipped with chain grates, installed by other companies.

The average efficiency obtained, 68.4 per cent., compares favorably with the efficiencies of 69.5 and 69 per cent. obtained on the shorter runs with a single boiler. The cost to evaporate 1000 lb. of water from and at 212 deg. F. was 8.6c. on the 24-hr. run as compared with 8.2c. and 8.7c. obtained on the short runs.

The 24-hr. average for CO_2 in the flue gases leaving the boilers was 7.58 per cent.; O, 12.4 per cent. and CO, 0.014 per cent., but the averages for the same time from three of the five boilers tested were CO_2, 10.30 per cent.; O, 9.03 per cent. and no CO. The reason for this difference was that on the two boilers having low values of CO_2 there was a space about 1 in. wide, extending the entire width of the furnace, between the stationary and movable

portions of the arch over the grate. This opening allowed a large amount of air to enter the furnace directly over the coking plates; while on the three other boilers this opening was closed with asbestos, allowing no air to enter at this point, but not preventing the circulation of air for cooling the arch.

To show the effect on the heat balance of closing this opening, the results from these three boilers were figured to show the loss due to heat carried away in the chimney gases, which amounted to 18.7 per cent., as compared with 24.75 per cent. for the entire 24-hr. run. Assuming that five-sixths of this heat would have been transmitted to the boiler, the efficiency of the boiler would have been increased to 73.4 per cent.

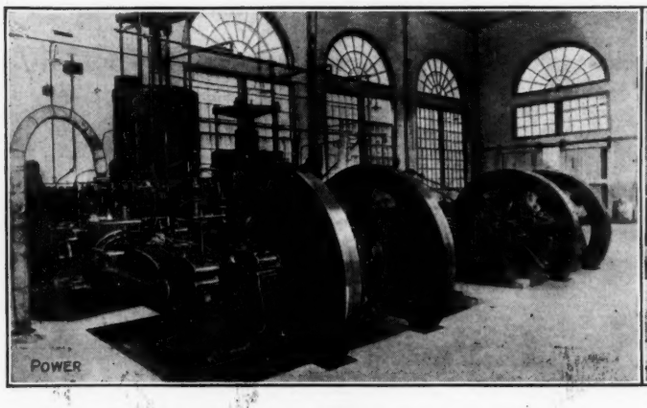


FIG. 4. TWO 200-GAL. HIGH-PRESSURE PUMPS

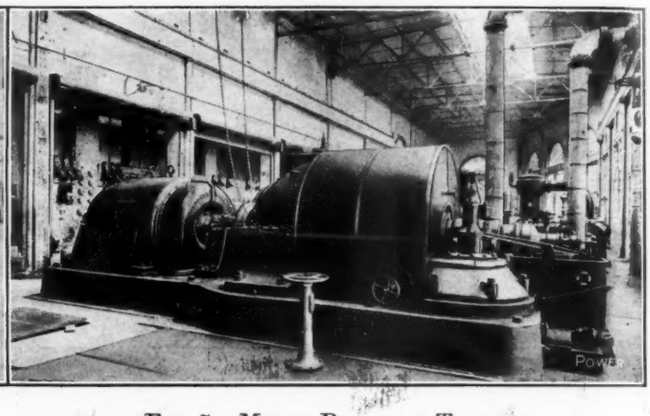


FIG. 5. MIXED-PRESSURE TURBINE

TABLE 3. GENERAL RESULTS OF 24-HR. PLANT TEST

Fulton engine, average i.hp.	1400
Hamilton engine, average i.hp.	1579
Pressure in exhaust header, lb. per sq.in.	1.52
Rateau turbine, low-pressure inlet pressure, in. of mercury	7.83
Rateau turbine, high-pressure inlet pressure, lb. per sq.in.	11.9
Vacuum, in. of mercury	27.04
Allis-Chalmers turbine, low-pressure steam pressure, in. of mercury	4.15
Allis-Chalmers turbine, low-pressure inlet pressure, in. of mercury	11.36
Vacuum, in. of mercury	27.01
Average total engine horsepower	2979
Engine load factor, per cent	74.5
Average total output, kilowatt	1690.8
Turbine load factor, per cent	53.2

Table 3 gives only a few of the results of the 24-hr. plant test. While much of the data obtained is of value only to the Goodyear company, there is one result which should be of general interest; this relates to the cost of electric power generated by the low-pressure turbo-generators. Practically all of the steam for operating these turbines came from the two cross-compound Corliss engines which developed an average of 2979 hp. during the test. If these engines had been operating condensing they would probably have developed about 20 per cent. more power, so that the cost of the steam for this 600 hp. is all that should be charged up to the turbines so far as steam consumption is concerned.

Figuring this cost from the results of the 24-hr. plant test, the steam consumption of the engines and auxiliaries before installing the turbines having been found to be 20.35 lb. per hp.-hr., gives a cost for fuel to produce steam for the low-pressure turbo-generators of approximately $25 per day. Taking the cost of labor at $8.50, supplies and tools at $3, and repairs at $7 per day, gives a total cost for the operation of the turbo-generators of $43.50 per day. Adding to this fixed charges of 13 per cent., on an investment of $120,000 for turbo-generators, condensers, switchboard, etc., or a fixed charge of $52 per day, represents a total daily cost of $95.50 per day for operating the low-pressure turbo-generators. The average output per day, as shown by the test, was 1691 kw. per hour, or 40,584 kw.-hr. per 24-hr. day. Dividing $95.50 by 40,584 gives 0.235c. per kw.-hr. as the total cost of electric power, including fixed charges, as generated by the low-pressure turbines at the present time, with a load factor of 53.2 per cent.

TABLE 4. PRINCIPAL EQUIPMENT UNDER 24-HR. TEST

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
5	Boilers	Stirling	822-hp.		175-lb. steam pressure	Babcock & Wilcox Co.
5	Stokers	Chain grate	182 sq.ft.			Green Engineering Co.
1	Engine	Cross-compound	1500 hp.	Driving line shafting	Noncondensing	Fulton Iron Works
1	Engine	Cross-compound	2500 hp.	Driving line shafting	Noncondensing	Hooven, Owens, Rentschler Co.
1	Engine	Cross-compound	450 hp.	Driving air compressor	Noncondensing	C. & G. Cooper
1	Turbo-generator	Low-pressure	1500 kw.		Condensing	Southwark Foundry & Machine Co. Crocker-Wheeler Co.
1	Turbo-generator	Mixed-pressure	1680 kw.		Condensing	Allis-Chalmers Co.
1	Condenser			With Allis-Chalmers turbine		Allis-Chalmers Co.
1	Condenser	Le Blanc		With mixed-pressure turbine		Westinghouse Machine Co.
1	Steam turbine			With Allis-Chalmers condenser		Terry Steam Turbine Co.
1	Air compressor	Two-stage	16½ & 27½x36-in.			Ingersoll-Rand Co.
2	Steam pumps	Direct-acting	14 & 20x3¾x24-in			Laidlaw-Dunn-Gordon Co.
1	Motor driven pump	Two-stage	5000-gal.		Discharging against 100 lb.	De Laval Steam Turbine Co., Pump Crocker-Wheeler Co., Motor
1	Steam pump	Direct-acting Burnham	1500-gal.		Discharging against 180 lb.	Union Steam Pump Co.
1	Steam turbine	Six-jet		Driving Jeansville 1100 gal. turbine pump		Terry Steam Pump Co.
1	Steam pump	Low-service	10 & 14x16-in.	Makeup water		Union Steam Pump Co.
1	Heater	Open	10,000 hp.	Feedwater		Hoppes Mfg. Co.
1	Motor-generator set	Three-wire	500 kw.			Crocker-Wheeler Co.
1	Motor-generator set	Two-wire	150 kw.			Crocker-Wheeler Co.
1	Motor-generator set	Two-wire	75 kw.	Excitation		Crocker-Wheeler Co.

Measure of Damages for Removal of Dam—When a dam is condemned for public use, such as a drainage improvement, the owner is entitled to recover the consequent depreciation in the value of his property to which the dam has been appurtenant, plus the value of the water power lost. But on the condemnation of a dam, which has been used only in the operation of a mill, the owner is not entitled to be reimbursed for profits which might have been derived in the future from the use of the dam in developing electric power, if there was no present intention to provide for such development. (Nebraska Supreme Court, Maynard vs. Nemaha Valley Drainage District No. 2, 143 Northwestern Reporter 927).

Louisville Spray Cooling Pond

At the power plant of the Louisville Cotton Mills, Louisville, Ky., is a compact spray, cooling-pond system, as shown by the illustrations. Fig. 1 is a photograph of the pond and nozzles, taken during the noon hour when the main power engine was shut down.

Rel. Humidity 66-30-48 LOUISVILLE COTTON MILLS CO.
Max. Temperature 96 Incorporated
Min. Temperature 74 CONDENSING SYSTEM Sept. 2,1913
(Hourly Records)

Time		Temperature of Injection	Temperature of Discharge	Difference	Vacuum	Barometer	Remarks
7 A. M.		88	106	18	26	30-22-30-10	
8 "		90	111	21	25.75		
9 "		93	114	21	25.50		
10 "		94	114	20	25.25		
11 "		96	115	19	25		
11.45 "		98	116	18	25		
1 P. M.		96	114	18	25.75		
2 "		98	114	16	25.75		
3 "		98	115	17	25.75		
4 "		99	116	17	25.75		
5 "		99	116	17	25.50		
5.30 "		99	116	17	25.50		

Rel. Humidity 66-88-77 LOUISVILLE COTTON MILLS CO.
Max. Temperature 32 Incorporated Dec. 8, 1913
Min. Temperature 19 CONDENSING SYSTEM
(Hourly Records)

Time		Temperature of Injection	Temperature of Discharge	Difference	Vacuum	Barometer	Remarks
7 A. M.		75	102	27	27	30-32-30-46	
8 "		76	100	24	27		
9 "		75	98	23	27		
10 "		75	98	23	27		
11 "		76	99	23	26.7		
11.45 "		76	100	24	26.5		
1 P. M.		76	97	23	27		
2 "		74	97	23	27		
3 "		75	98	23	27		
4 "		76	99	23	27		
5 "		77	99	22	27		
5.30 "							

The cooling pond is 50 ft. in diameter and 11 ft. deep to the overflow. The brick sides are lined with concrete; the bottom is also of concrete. In case of fire the pond water can be used to supply the mill automatic sprinkler system.

The outside spray nozzles are set in semi-ring headers of 24-ft. radius, made up of 2½-in. pipe at each plugged end, with a 7-in. pipe connecting with the 12-in. supply main, and intermediate pipe sizes, as in Fig. 2.

In the center of the pond is a circular header into which eight branch pipes are screwed, four 5-ft. and four 10-ft. long. The header is supplied with water through a 7-in. line connecting with the cross fitting of the 12-in. supply pipes. These branch pipes each carry a 2-in. spray nozzle, placed vertically at the outer end. The 16 two-inch nozzles on the ring headers are placed at an

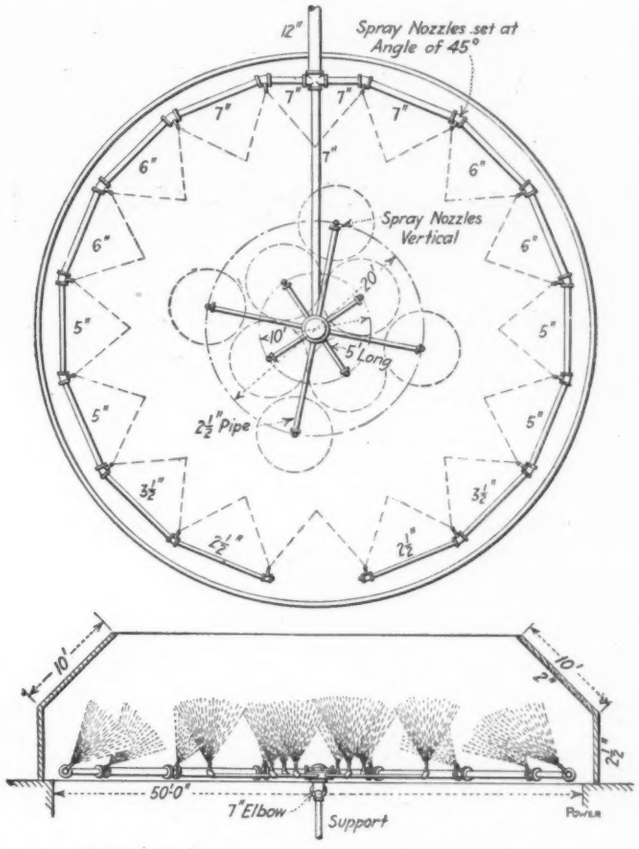


FIG. 2. PIPING OF SPRAY COOLING POND

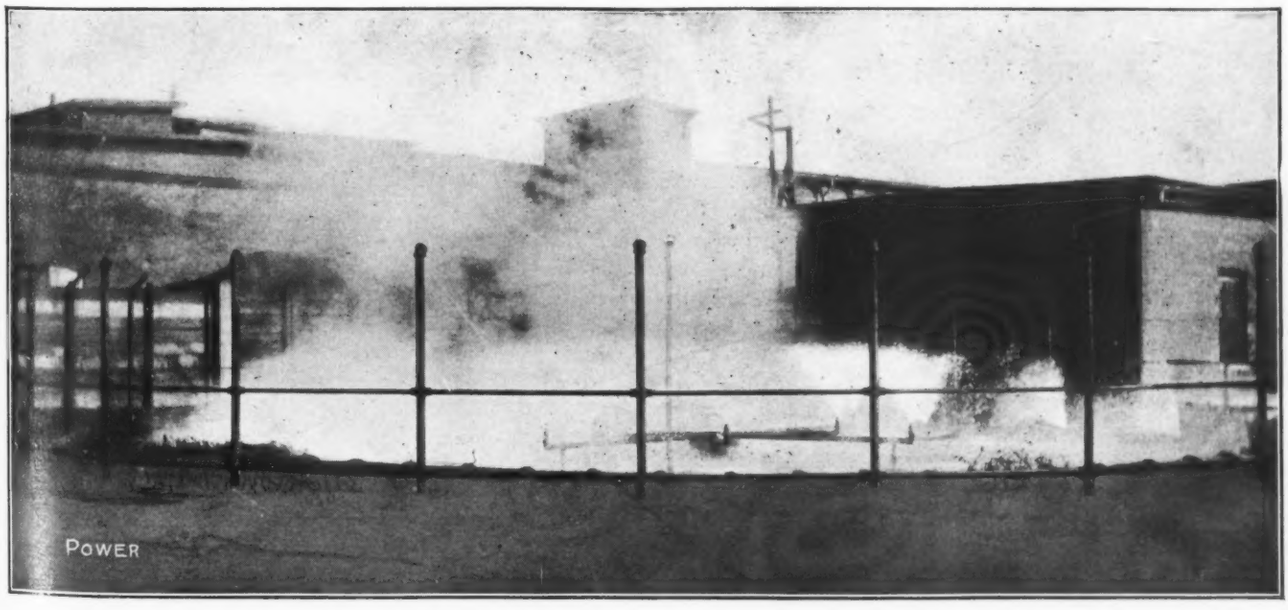


FIG. 1. SPRAY NOZZLES IN ACTION UNDER LOW HEAD

angle of 52 deg. The center circular header is secured to a 7-in. elbow to which a support is screwed.

To prevent a loss of water in the form of spray, the pond will be surrounded with a pipe framework of 30 vertical, 2½-in. pipes, 7 ft. high, the upper end of each being fitted with a 45-deg. ell into which 10-ft. lengths of 2-in. pipe are screwed. These upper pipes will be covered with wood sheathing to catch the spray.

These spray nozzles cool the condensing waters for a 26 and 52 by 48-in. cross-compound Corliss engine. The water is pumped by a 20 and 30 by 20-in. Dean Bros. vertical jet condenser. The suction pipe connecting the condenser and pond is 10-in. in diameter; the discharge pipe is 12 in. Water is forced through the Schutte & Koerting ⅝-in. spray nozzles at between 7 and 9 lb. head.

At the time of the writer's visit, the temperature of the water returning to the nozzles was 102 deg., with a 27-in. vacuum; the water returned to the condenser at 80 deg. During the summer months the average vacuum carried is 25 in. with a discharge-water temperature of 110 deg. and a return temperature of between 90 and 95 deg.

In the data sheets, Fig. 3, is shown the readings of extreme atmospheric conditions with hourly readings of temperature, etc. Thanks for the foregoing are due John T. Hebden, chief engineer and master mechanic, under whose direction the equipment was installed.

Soot in Relation to Boiler Economy

By F. W. Linaker

The article on the effect of soot on boiler economy by E. D. Fisher, in Power, Dec. 9, 1913, was of interest, but his experience with soot as affecting the efficient and economical operation of a boiler plant is not in accord with either the generally accepted views or the writer's experience.

The article states that test *A* was run one week after the tubes had been thoroughly swept and the boiler operated as usual without blowing or cleaning the tubes. Test *B* was run two weeks after test *A*, and one week after the tubes had been swept, the boiler being operated as usual and the tubes blown daily. The tests were of two hours' duration, and were started and stopped by the alternate method.

In a test of but two hours' duration almost any results that the operator might desire could be obtained, but to get dependable results in so short a run would be impossible. The condition of the boiler, and the method in which the tests were conducted, would lead to gross inaccuracies, and, as this is a common fault among observers making tests to determine the relation of soot to boiler efficiency, this is an excellent opportunity to call attention to the cause of these inaccuracies.

A well designed soot blower is intended to keep the heating surface of a boiler in a clean condition indefinitely, if used daily, provided the heating surface is thoroughly cleaned to start with. A blower that is capable of keeping the tube surface in a clean condition may not be capable of digging up old deposits of soot and ash that have accumulated in the past, and may be so caked and packed in nooks and corners as to resist blowing of any kind, especially where the ash has had opportunity to fuse and run, forming a more or less solid mass. When such conditions exist no blowing device can do itself justice.

In making comparative tests the heating surface should be thoroughly swept and cleaned before each test. Then after a week's or a two weeks' run, with either method of cleaning employed, the boiler can be considered to be in its average condition. A test conducted in this manner is a real comparative test. If a mechanical blower has to start with dirty and soot-packed boiler tubes it cannot make a proper showing.

In the article referred to, it is stated that a bad feature of soot blowers which require a number of jets piercing the boiler wall is, that the brickwork cracks, and in consequence air leakage through the setting occurs.

One case is cited where it was found, from gas samples taken over the fire in the first pass, that there was 11.6 per cent. CO_2 corresponding with 77 per cent. excess air, while in the back connection simultaneously samples showed only 5.8 per cent. CO_2, corresponding to 280 per cent. excess air. Such a drop in CO_2 indicates nothing, so far as soot blowers may be concerned, but indicates that the engineer in charge was guilty of tolerating a setting that was little better than a sieve. Anyone experienced in gas-analysis work could mention many cases where the air

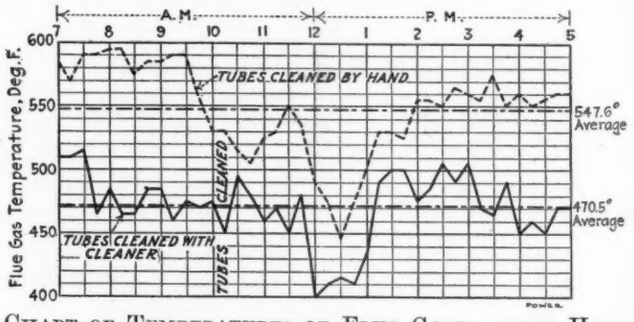


Chart of Temperatures of Flue Gases, with Hand and Cleaner Blown Tubes

leakage was far greater than the case cited and where no mechanical soot blowers were installed.

This objection to air leakage through the setting may apply to some types of apparatus, but it is a safe guess that from 50 to 80 per cent. of all air leakage into the furnace is through cracks and crevices in doors, between the frames and brick-work, and where the walls are made thinner on account of the blow doors.

There are mechanical blowers, installed independently of the side blow doors, with wall sleeves set solidly into the side wall. These pipes and sleeves can be so cemented into the wall that the setting is tight. Such a blower reduces air leakage, as there are no blow doors to open while cleaning, and it is possible to seal them, when present, in a permanent or temporary manner.

Every time boiler tubes are blown by hand, there is an inrush of cold air that chills the tubes and dilutes the gases. Chilling the tubes will, in time, cause contraction

and leakage. Diluting the gases lowers the efficiency. This can be demonstrated by a flue-gas analysis. During the hand-blowing period there will be found a drop in the CO_2, averaging 4 per cent., say from 10 to 6 per cent. CO_2. The sealing of blow doors cannot be too vigorously urged, for air leakage through settings is detrimental to both draft and economy.

On all types of boilers equipped with a properly designed soot blower it is not necessary to use the clean-out doors, except for inspection purposes, and, therefore, a temporary or permanent seal of those doors may be made, thus insuring a tight setting. These simple precautions are bound to increase the CO_2, in some cases as much as 4 per cent.

To illustrate the tightness of settings obtainable with some soot-blowing systems one of the largest electric-power plants in Detroit is equipped with a certain soot-blowing outfit which has been in use for the past eight years on 50 boilers, a total of 31,250 boiler horsepower being equipped, together with blowers for the economizers.

The plant runs with an average of 14 per cent. CO_2. The engineers say that they could increase their CO_2 if they desired, as during one test made to determine the efficiency of different styles of baffling on a boiler equipped with this soot-blowing device they obtained 17 per cent. CO_2.

These figures show that a well designed soot blower, properly installed, is not the cause of air leakage, but rather goes hand in hand with a tight setting.

The accompanying record is taken from the manufacturers' catalog, and is of a test made to determine the efficiency of the type of soot blower above referred to. The figures of the record have been verified by inquiries at the plant of the Champion Coated Paper Co., Hamilton, Ohio, where this test was made. They were made on a horizontal water-tube boiler. Test No. 1 was taken before the soot cleaner was installed; test No. 2 after the soot cleaner was installed.

	Test No. 1	Test No. 2
Duration of test	10 hr.	10 hr.
Average steam pressure	150 lb.	151 lb.
Average temperature of water to economizer	167°	172°
Average temperature of water to boiler	253°	219°
Coal as fired	20,929.5 lb.	18,661 lb.
Water evaporated	199,686 lb.	191,671 lb.
Ash	11%	11.7%
Moisture	0.86%	0.69%
Equivalent evaporation of water per lb. coal with economizer	10.5 lb.	11.36 lb.
Equivalent evaporation of water per lb. coal without economizer	9.62 lb.	10.76 lb.
Gain for economizer	8.76%	5.28%
Average temperature of gases to economizer	669°	502°
Average temperature of gases to stack	500°	384°
Horsepower developed	601	610
Percentage of boiler rating	200	205
Average CO_2	Not taken	13.5%
Draft entering economizer	0.2 in.	0.2 in.
Calorimeter test	12,171 B.t.u.	14,279 B.t.u.

The foregoing tests show a gain of over 7½ per cent., for which the credit is due to the soot-blowing apparatus, as the tests, as far as possible, were run under otherwise identical conditions. Unfortunately the CO_2 was not taken when this boiler was cleaned by hand, but the percentage of CO_2 when the soot blower was in use was 13.5 per cent., which shows that the settings were in excellent condition. The stack temperature shows a reduction of 116 deg. F.

An engineer with an eye for economy looks carefully after his boiler setting so as to reduce the air leakage to a minimum. The practice of encasing the whole setting in steel is excellent and is increasing, but engineers realize that there is a greater gain if the blow doors are also encased, as it is practically impossible to keep these doors air-tight. To overcome this difficulty, it has become common practice to omit the dusting doors and steel case the entire setting, and install some type of mechanical soot blower for cleaning the boiler tubes.

One of the largest New York companies recently installed thirty-two 600-hp. horizontal water-tube boilers, 14 tubes high by 21 tubes wide. These boilers are steel cased with no provision for hand cleaning. The boilers are cleaned by means of a mechanical soot-blowing system, consisting of eight 2-in. blow pipes, which extend across the width of the boilers. Four of these pipes are at the top of the first pass, two at the top of the second pass and two at the top of the third pass. Each pipe is equipped with special three-way nozzles drilled so as to project the steam obliquely between the tubes. The nozzles on alternate blow pipes project the steam down through the space between the tubes on intersecting planes and between different pairs of tubes, so that the steam crossfires over the heating surface. An additional 2-in. pipe with smaller branch blow pipes cleans the superheater.

In the article under discussion the statement is made that the worst feature of all forms of fixed-jet apparatus is that they cannot be spaced close enough to effectively clean the tubes. This statement seems hardly in keeping with the evidence at hand. The foregoing tests indicate that the soot blowers reach considerable soot that is inaccessible to hand blowing.

Many of the most progressive power plants in the country, especially in the electric-light and railway field, have been using mechanical soot cleaners for years and have placed repeat orders until every boiler is equipped with such blowers, which is evidence that the cleaners must be real soot removers.

The fact that users of the latest improved soot-blowing systems do not go within the settings to remove soot by hand would further indicate that such blowing systems are efficient. In the case of hand blowing, however, it is always necessary to resort to such periodic cleanings, which, as Mr. Fisher states, is an acknowledged failure.

One of the main troubles experienced in trying to blow soot from boiler tubes by a hand steam lance is the impossibility of using one long enough to reach across the boiler. This results in the soot piling up on the tubes at the far side of the boiler. With the boilers set in batteries, as is the usual practice, it is impossible to overcome this difficulty when blowing the tubes by hand. Even where it is possible to use a lance across the boiler width, this blowing does not clean the sides of the tubes, which play an important part in the evaporation of water.

The soot clings to the tube side, defying removal by hand blowing, and the soot on the tops of the tubes at either side of the blow doors remains untouched. The bulk of the soot that is reached by the hand blowing is really not all removed, but is stirred up and a portion settles on the tubes again. Cleaning the top of a tube prevents some waste, but a properly designed soot cleaner cleans the whole tube surface and is much more efficient.

To further illustrate the losses occasioned by soot on boiler tubes the results obtained at one of the largest electric plants in the country are as follows: Starting with a clean 600-hp. horizontal water-tube boiler at 50 per

cent. over rating, the gas temperatures in the uptake were:

	Degrees
First day	550
Second day	575
Third day	600
Fourth day	625
Fifth day	650

These boilers had no blowing system, and in fact were not even blown by hand, and the increase in uptake temperature is significant.

Another test which emphasizes even more strongly the importance soot plays in relation to boiler efficiency, and also illustrates the efficiency of the mechanical soot blower employed, was conducted by recognized engineers at one of the largest electric-lighting plants in the Middle West.

On a new 750-hp., water-tube boiler, never before fired, the tubes were blown at the end of the first hour's run and immediately there was a drop of 20 per cent. in the uptake temperature. Twelve hours later the tubes were again blown and a drop in the uptake temperature of of between 65 and 70 deg. took place. These figures show the effect that soot has on boiler efficiency and also show the importance of frequent and thorough cleaning.

Mr. Fisher states that with good firing a reduction of 50 deg. F. in the flue temperature will mean a saving of 3 per cent. in the coal bill. In connection with this statement, which is acknowledged to be approximately correct, it will be interesting to study the accompanying chart, which was taken at one of the largest cotton mills in Massachusetts.

During the afternoon of the day of the test, experiments were being made with a new grade of coal and new methods of firing, in consequence of which the readings of temperature during the afternoon were erratic. However, accepting the average as shown by this chart, it will be seen that the soot-blowing device, while not receiving all credit due it, still shows marked economy. On the boiler equipped with the mechanical soot blower the chart shows an average reduction in uptake temperature of 77 deg. F. in comparison with the boiler cleaned by hand. This 77 deg. F. reduction represents a 4.6 per cent. saving in fuel. Who would question if the money expended for that soot blower is paying a dividend?

Mechanical soot blowers have been in process of development for the past 10 or 12 years, during which time much valuable experience has naturally been gained by the pioneers in this field. Soot cleaners installed without the proper experience or design back of them can hardly be expected to give the best results, but to include all types of soot blowers under a general condemnation is too sweeping.

Most engineers admit that soot defies removal by hand blowing. It is generally admitted that the mechanical blower correctly designed, properly installed and intelligently operated is the real solution to the soot problem.

Calculating Power in Alternating Current Circuits--III

By Norman G. Meade

SYNOPSIS—The use of synchronous motors for improving the power factor, and the characteristics of such machines.

So far, the causes and effects of leading and lagging currents have been considered and reasons given why the power factor should be maintained as high as possible. It has already been stated that synchronous motors can be used to correct lagging currents. Before taking up this feature it may be well to study the characteristics of such machines.

In construction synchronous motors resemble alternat-

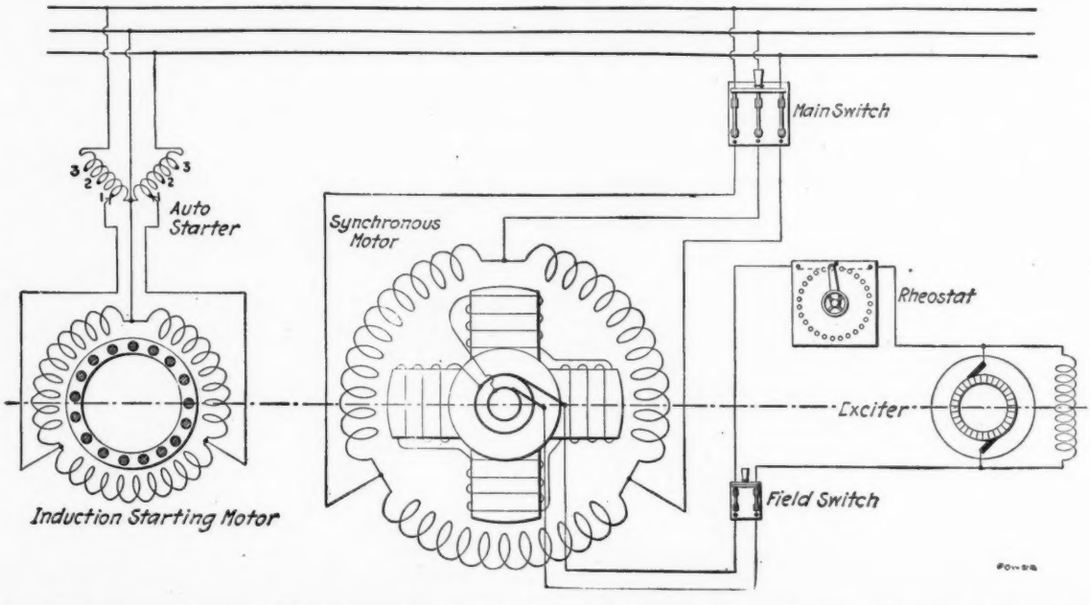


Fig. 15. Connections of a Two-Phase Synchronous Motor with Its Starting Motor and Exciter

ing-current generators, and they are usually of the revolving field type. The fields are excited by direct current generally supplied from an exciter belted to or directly connected to the motor. A synchronous motor will run in synchronism with a similarly constructed alternator after it is brought to the same speed, or, if the number of poles in the two machines are not the same, to some multiple of the speed of the generator, provided the number of pairs of poles on the motor is divisible into this multiple. Such motors will operate as though geared to the

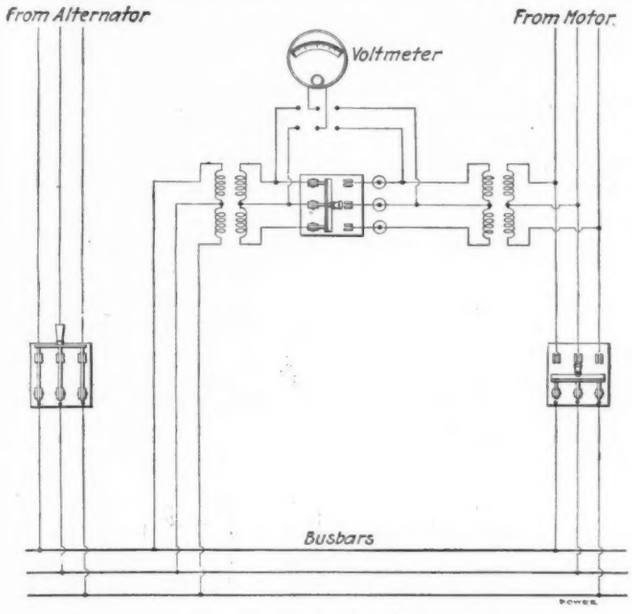


FIG. 16. CONNECTIONS FOR SYNCHRONIZING

generator even up to two or three times their normal full torque capacity.

Polyphase synchronous motors (single-phase synchronous motors are rarely used) will come up to synchronism, giving about 25 per cent. starting torque, when started as induction motors with the field open.

When connected to lines with an inductive load overexcitation of the motor field acts in the same manner as a condenser introduced into the line, and tends to restore the current to phase with the impressed electromotive force and, therefore, do away with inductive disturbances.

Two general methods of starting synchronous motors are in use, namely, by a separate starting motor, or by self-starting. Where the machine is single-phase, a direct-current motor is usually employed for starting, but where polyphase current is used the starting motor is usually of the induction type.

In self-starting, the application of alternating currents directly to the stationary armature without field excitation, will result in a rotating magnetic field about the armature core. The eddy currents thereby produced in the pole faces will exert a torque on the rotor and will cause it to speed up to synchronism. Usually a starting compensator is employed for reducing the applied electromotive force during the starting period.

When starting synchronous motors the field is open-circuited. In practice the field coils are connected in various ways to obviate the danger of high induced voltage. One way is to use a low-voltage excitation and few turns on the field coils, or the field coils may be split up by a switch at starting, and when the motor reaches synchronous speed the excitation is thrown in.

The use of a separate starting motor is especially advantageous with synchronous motors, for with self-starting large lagging currents are taken from the line. Since the induction motor must have some slip, it is necessary in order to bring the synchronous motor to full synchronism, that the starting motor shall have fewer poles than the main motor. Fig. 15 shows the principal connections of a two-phase synchronous motor with its starting motor and exciter.

Before a synchronous motor can be put into service it must be brought up to synchronous speed and into step with the supply system. Some methods of indicating synchronism must be employed before the main motor switch is thrown in, when the synchronous motor is started by a separate starting motor. The common method is to use incandescent lamps, or a synchroscope as in synchronizing alternators. The connections are shown in Fig. 16.

Care must be exercised in the use of synchronous motors and their best condition of operation is when the load is quite steady, otherwise they introduce effects on the line that are quite troublesome. The field of such a motor can be adjusted for a particular load, so there will be neither leading nor lagging currents, but unity power factor. If the load changes, then the power factor also changes, until the field is readjusted. If the current has been lessened then the current will lead, but if it increases the current will lag.

If two or more synchronous motors are connected to the same circuit, and the load on one is variable, and its field is not changed to meet the changing conditions, a hunting effect is likely to take place in the other motors unless special provision has been made to prevent it.

Assume that the load on the generator suddenly varies to a considerable extent, when a large load is suddenly thrown off. The generator will tend to speed up. The motor naturally will follow this increase in speed, but the inertia of its moving parts will cause an instantaneous lag in the speed and the two machines will be slightly out of step, causing cross-currents to circulate between the two machines. The motor will come up to synchronous speed, but the effects of inertia are still present and it will run ahead of synchronous speed, causing cross-currents to be set up again. This oscillation will take place for a few seconds. The effects of hunting are minimized by placing copper grids in the pole tips of the field poles.

Electrical Instruction for Pennsylvania Employees—In announcing that it will establish schools of electrical instruction for its employees at Conemaugh, Derry, Gallitzin, Cresson, Pitcairn and Pittsburgh, the Pennsylvania R.R. has given rise to the report that the intention is to electrify the Pittsburgh division, which extends from Pittsburgh to Altoona, a distance of 119 miles. In this stretch is the big mountain range at the summit of which is the Gallitzin tunnel and at the eastern end of the tunnel begins the big descent that is known as the famed "Horseshoe Bend." This 119 miles from Pittsburgh to Altoona is considered one of the most difficult problems in steam railroading in America. Should the Pennsylvania install electric power on this division it would be only a question of time until the entire system would be electrified. The Pittsburgh division is the really big problem with the Pennsylvania Railroad. The new schools are to be equipped with all the apparatus used in the electrical operation of trains and the various phases of the method will be explained in theory and practice. Among transportation men in Pittsburgh this move by the Pennsylvania is regarded as peculiarly significant.

How a CO_2 Recorder Works

By Charles H. Bromley

SYNOPSIS—Telling in a simple way how and why a CO_2 recorder is able to record the percentage of CO_2 in the flue gases.

When you use a sponge to soak up water from the floor you do not consider that anything remarkable has happened. You have seen the tanks at the gas works rise as they filled with gas, and drop down as the gas was discharged, and you thought that a usual proceeding.

The principal reasons why a CO_2 recorder records CO_2 are really no more mysterious nor remarkable than the absorption of water by a sponge, or the inflation of a tank by gas. Practically, the same physical actions occur in both cases, but the things we use are different.

Because chemicals have unfamiliar names, is no reason why we should shy at them any more than we shy at a yeast cake, which is a chemical. Some chemical solutions absorb certain gases just as a sponge absorbs water. You know that to relieve a gas-bound ammonia pump you let the gas discharge into a pail of water. If the gas were

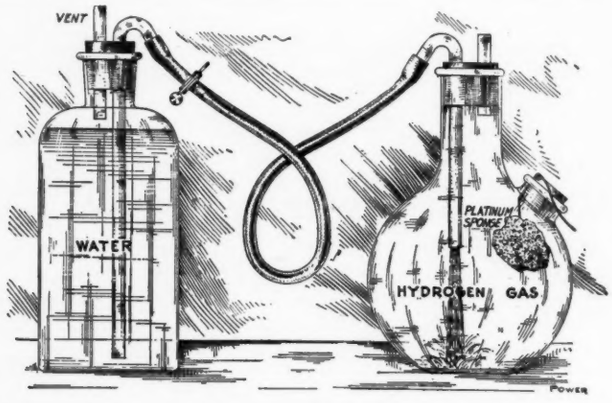


Fig. 1. Absorption of Gas by Platinum Sponge Creates Vacuum in Bottle

discharged into the room the fumes would be quite disagreeable, but when discharged into the water the gas is absorbed like water by a sponge.

Platinum sponge will absorb a surprisingly large amount of hydrogen gas, and the sponge will not increase in volume. To prove that it will absorb this gas we will arrange two bottles, as in Fig. 1. One is filled with water, the other with hydrogen gas. We suspend a piece of platinum sponge in the gas as shown. The sponge will then absorb the gas, create a vacuum in the bottle and draw into it water from the other bottle.

The first experiment showed that some substances do absorb gas. We will now experiment with a sample of flue gas of 100 c.c.; 12 per cent. is CO_2 and the other 88 per cent. is made up of other gases.

We have four bottles, Fig. 2, one containing 100 c.c. (cubic centimeters) of water; one, 100 c.c. of flue gas; one with a caustic-potash solution and the last bottle we will consider inverted and full of water. Opening the pinch cocks on the rubber tubes connecting the bottles, lift the water bottle to the position indicated by the dotted lines. The water flows into the second bottle, forcing the 100 c.c. of flue gas out, causing it to bubble up through the caustic-potash solution. After the gas has passed through the solution, an analysis would show no CO_2, but it would show that 88 c.c. of other gases were present. At the beginning of the experiment the inverted bottle is filled with water and is sealed by a little water in the jar, just as the spring-water-bottle drinking fountains are arranged. If the flue gas contains 12 per cent. CO_2 and this bottle is lifted as the gas comes into it, so that the water levels in the jar and bottle are the same, the

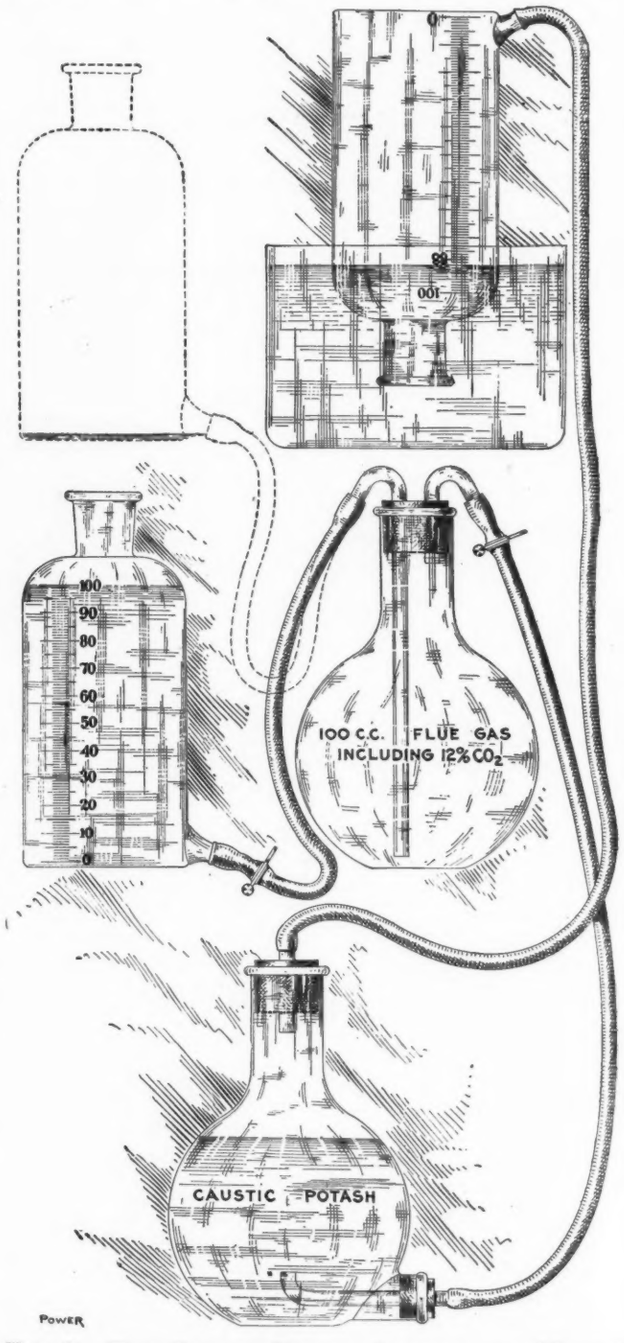


Fig. 2. The Caustic Potash Absorbs the CO_2, but the Other Gases Pass On

water will run down to the 88 c.c. or per cent. mark and the gas will be at atmospheric pressure, as it has been throughout the experiment. The other 12 per cent. of the gas or the CO_2 did not get through the caustic potash.

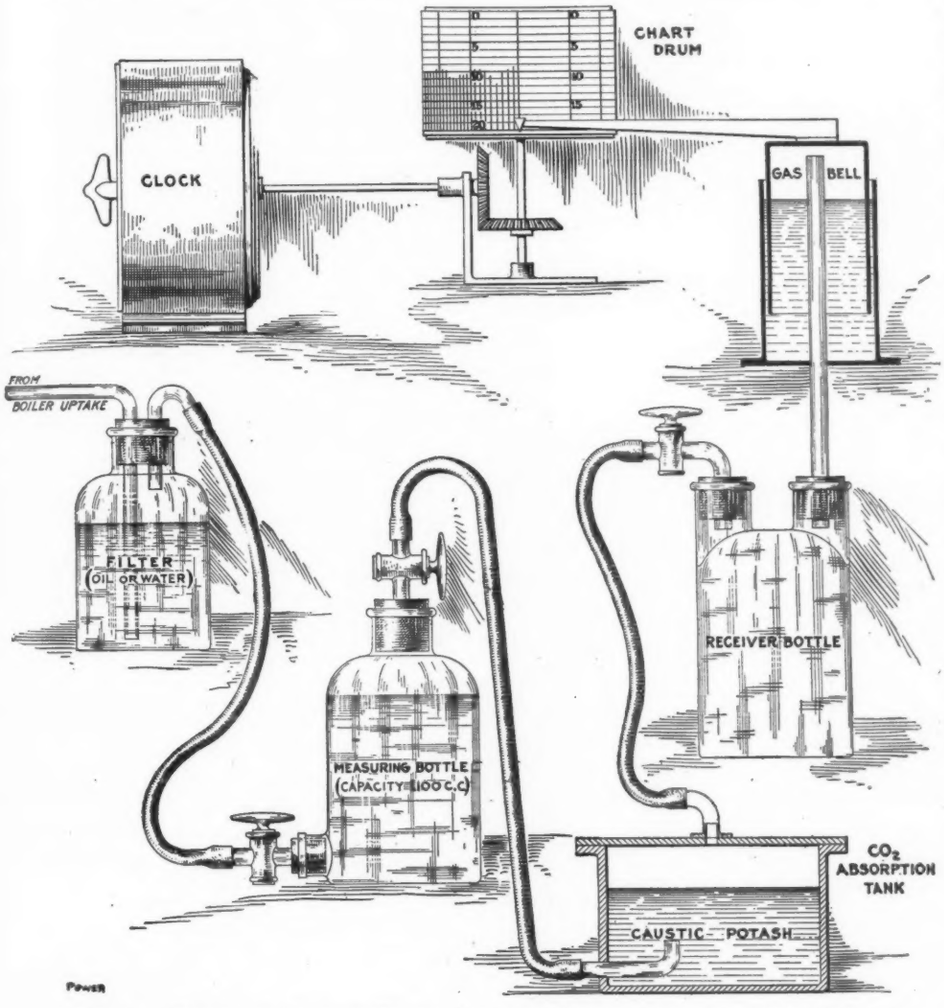


FIG. 3. HERE, IN SIMPLE FORM, ARE THE ESSENTIALS OF A CO_2 RECORDER

This experiment demonstrates that a caustic-potash solution absorbs only the CO_2 in the flue gases but allows the other gases to pass through. About the same process as that gone through in this last experiment goes on in a CO_2 recorder.

In the recorder the chemical or "sponge" which absorbs the CO_2 is caustic potash. The pen which marks the chart is attached to the top of a gas bell that rises and falls as it is filled with and emptied of the CO_2 gas, just as the tanks at the gas works rise and fall.

Before continuing, let us understand why we say such and such a percentage of CO_2. Percentage means "by the hundred," and 10 per cent. or 12 per cent. means 10 or 12 parts of a total of 100 parts. The total of 100 parts, or 100 per cent., may be any quantity we choose to make it. In measuring CO_2, all or 100 per cent. of the sample of gas taken from the flue is 100 cubic centimeters (c.c.), or a little over 6 cu.in. When the flue-gas analysis shows 12 per cent. CO_2 we know that 12 parts, or 12 c.c., of the 100 parts, or 100 c.c., is CO_2 gas.

Fig. 3, shows the essentials of a CO_2 recorder, and when you understand it, you will understand how and why any CO_2 recorder works. The gas is brought from the boiler uptake and passed up through the filter, which contains a bottle nearly filled with oil or water to take out the soot in the sample. Gas flows into the measuring bottle, which holds exactly 100 c.c., or about 6 cu.in. The sample having been measured, it goes to the "sponge," or caustic-potash solution, where all the CO_2 gas is absorbed, and the rest bubbles through the solution and fills the receiver bottle. From the receiver bottle the gas is led to the gas bell, which has a water seal so that gas cannot escape to the atmosphere. This bell and the pen arm rise and mark the chart against which the pen bears. When the mark is made the gas goes back through the pipe *A* and eventually goes to the atmosphere. The chart drum is revolved by clockwork, as usual.

As the caustic potash absorbs only CO_2 we see that if the measured sample is high in CO_2, there will be less gas going through the solution to fill the gas bell, and the pen will not make as long a mark as when more gas is passing through the solution. On a recording steam gage or thermometer the pen makes a longer mark as the pressure or temperature increases from the zero point on the chart. This is not so with the CO_2 recorder of this sort. The greater the CO_2 percentage, the shorter the mark.

To get the gas into and out of the measuring and receiving bottles, caustic-potash tanks, gas bell, etc., many siphons and traps are required. The motive power for most CO_2 recorders is a stream of water flowing from a pet-cock. As the stream is increased the machine works faster; that is, it makes a greater number of readings per hour. With the usual CO_2 machine about seven or eight readings per hour will produce a good chart.

Short-Circuit Test of Large Generator

The photograph shows a 16,700-kv.-a. generator connected for a short-circuit test at the Westinghouse Works, East Pittsburgh. The test was made in the presence of representatives of electric companies, and the machine, running at full speed and generating current at 8800 volts without resistance or any other protection in the circuit, was deliberately short-circuited. Oscillogram records showed that a current of 21,000 amp., or 12½ times normal, flowed through the generator.

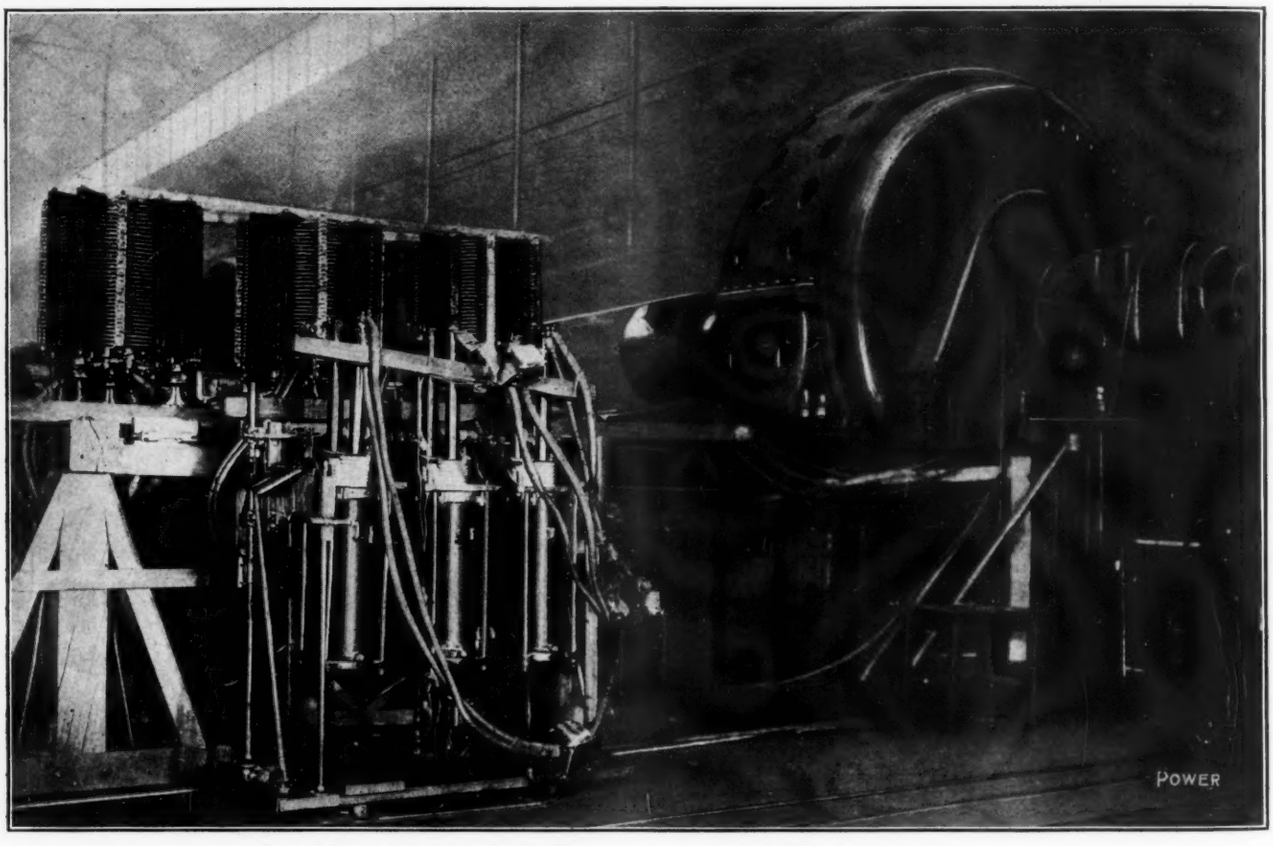
Such a test would have wrecked a generator designed some years ago, but in the present instance no damage

whatsoever was done. The only visible effect was a static flash between the field and the armature. The test was performed to prove that generators are being built requiring no protection from outside short-circuits, the generator itself being so designed as to be self-protecting. The destructive effects of a short-circuit are guarded against by firmly securing the armature coils and bracing their ends, and by the use of mica insulation.

In connection with this test, several others are carried out in order to prove the reliability of circuit-breakers and reactance coils for protecting the feeder circuits. The generator was repeatedly short-circuited through these devices which stood up under the enormous stresses to which they were subjected.

The practice recommended by the Westinghouse engineers is to perfect the feeders and not the generators. If the generators are protected and a short-circuit occurs on any of the feeders, even a poorly designed generator will not suffer, but the voltage will fail on all the feeders, all synchronous motors will be thrown out of step, and an overwhelming overload will be thrown on the circuit-breaker of the short-circuited feeder, since it will carry the total current of all the generators in the station. If, however, protective reactances are placed in each feeder circuit, and a short-circuit in a feeder occurs, only that feeder will be affected and even then its reactance coil will prevent the current in it from rising to too high a value. The voltage will be maintained at the busbars and no disturbances will be felt in the remaining feeders.

While it is possible to protect non-self-protecting generators by reactances, this is unnecessary since generators can be supplied that are immune to the worst conditions of load that can be imposed upon them.



LARGE GENERATOR UNDERGOING SHORT-CIRCUIT TEST

Recent Court Decisions

Digested by A. L. H. STREET

Risk Assumed by Engineer—An engineer at a power plant assumes the risk of being injured through breaking of a ladder which he is required to use, so far as concerns defects which an ordinarily prudent employee would discover in the same circumstances. (Indiana Appellate Court, Beard vs. Goulding, 103 "Northeastern Reporter" 875.)

Performance of Dam Construction Contract—Where a contract for the construction of a dam requires the core-wall to be extended down to and into impervious materials, but the drawings, which are made a part of the contract, prescribe a certain depth at which the wall is to be constructed, the contractor is not bound to extend the wall below the limit fixed by the drawings, although impervious material is not reached at that depth, he being entitled to assume that the depth fixed by the drawings was established after examination of the earth on the site of the dam. The contractor's rights in this regard are strengthened by the supervising engineer's acquiescence in the manner in which the work is constructed. (United States Circuit Court of Appeals, Ninth Circuit; Continental & Commercial Trust & Savings Bank vs. Corey Bros. Construction Co.; 208 "Federal Reporter" 976.)

Power Company as "Manufacturing" Corporation—A provision of the Minnesota constitution makes each stockholder in any corporation, except those organized for the purpose of carrying on any kind of manufacturing or mechanical business, individually liable for the debts of the corporation to the amount of stock held or owned by him. Feb. 13 the Supreme Court of that state held, in the case of the Vencedor Investment Co. vs. the Highland Canal & Power Co., of Duluth, that a corporation organized for the purpose of generating electricity for distribution to the public is a "manufacturing" corporation within the meaning of the exemption contained in this constitutional provision. The court decided that this conclusion is not to be affected by the fact that the corporation is vested with the power of condemning land in conducting its business. The opinion recognizes the fact that it is not in harmony with decisions in other states, but follows a Minnesota precedent, reversal of which the court says "would result in imposing a liability the stockholders did not intend to assume and create rights in creditors they had no right to expect or rely on."

Editorials

Designing Isolated Plants for Economical Service

The critical study of isolated-plant design is interesting and profitable. Scrutinizing new installations from the standpoint of the efficiency expert, to see how the design of the plant might have been bettered, is good practice.

An engineer, given the privilege of going over a large isolated plant, followed this course, and, without detracting from the good features of the design, noted for his own benefit the points which seemed defective in the installation.

The boiler room was about 50 ft. below the street, yet the architects, or whoever was responsible, failed to grasp the possibilities of gravity-coal delivery from the bunkers directly into the stoker hoppers. Instead, the fuel was delivered into hand cars from spouts near the boiler-room floor level, wheeled through a narrow doorway, dumped from the cars and shoveled by four coal passers into the stokers which were about 5 ft. above the floor. The cost of getting the coal from the spouts to the hoppers was $426 per month.

The visitor learned that a mechanical conveyor, about to be installed at a cost of $4200 to overcome the disadvantages of the original design, would save the owners $2572 per year, allowing 20 per cent. for fixed charges and operating costs. Adequate appreciation of boiler-room necessities in the first place rather than so much attention to the exclusively ornamental features by the architects would have meant lower annual costs for the owners.

In another case the efficiency of an isolated plant was found to be much lower than might have been expected on account of a large installation of indirect lighting fixtures, every pair consuming nearly a kilowatt, and some of them being operated ten hours a day. As a result a surplus of exhaust steam over that needed to heat the building was being wasted. Probably purchased current for such long-hour lighting business would have meant a lower total yearly expense. A heavy sustained lighting demand from morning until night is attractive to the central station, and such installations are giving the student of power economics food for thought.

Nothing is more important in the design of an isolated plant than the number and capacity of generating units selected. In a certain plant, there are five generators having a combined capacity of 1350 kw., or nearly twice the maximum demand. The visiting engineer noticed that the load averaged about 600 kw., the peak seldom exceeding 700 or 800 kw. Evidently, omitting one 300-kw. unit and its auxiliary plant would have saved nearly $15,000. Further, the engines were often run at part loads to avoid water in the cylinders arising from another defect—improper drainage of the steam lines. It appeared to the observer that the plant would do excellently with three generators of 750-kw. total rating, devoting one 150-kw. and one 300-kw. machine to the lights and a 300-kw. generator to the power load, the average lighting load being 370 and the power load, 200 kw.

Practical studies of this kind are helpful to the engineer who may some day be called upon to estimate the loads and equipment desirable for his employer's new plant. Over-powered isolated plants, with little likelihood of growth, may not cost the owner as much to maintain in yearly service as under-powered layouts, but they are none the less a source of excessive expense and deserve space in the personal note book of the visiting engineer when he is studying what to avoid in plant design as well as what is worthy of imitation.

Fairness to Understudies and Successors

No better test of the caliber of an engineer can be applied than to put him where he can treat both understudies and successors according to his own free will. Granted that there are many occasions where an engineer has every provocation to quit his work without lifting a finger on behalf of the future welfare of an ungrateful or unreasonable employer, it none the less follows that the man who can rise above these sources of irritation and give the best that is in him to the plant to which he has devoted himself so long as he is in a position to help matters, shows himself far superior to the fellow who nurses a grudge, and definitely raises the tone of his calling by his coöperative spirit. The treatment of understudies and nominated successors often calls for a large measure of tact and magnanimity, but there are so many practical ways of lending the helping hand to both classes of individuals that there is seldom much need of dwelling upon the trying phases of the situation from the emotional standpoint.

When an engineer realizes, either through his own choice or through circumstances, that a successor is slated for his position, and after he has made his own arrangements for taking up work elsewhere, there is often an interim of weeks or months before the change comes, and often the man who is going to leave has the opportunity to become somewhat acquainted with the chap who is to follow him. If an understudy is to take up the work, the opportunities for assisting the incoming man are sure to be numerous, unless through long assistance and apprenticeship the details of the plant are practically as familiar to one as to the other. Whether the new engineer comes from outside or inside the organization, the retiring man of the right sort will throw open every detail of his knowledge of the physical plant in his charge to his successor; he will show him upon request, or after an appreciated suggestion, the purpose and special features of all parts of the equipment which might be difficult to handle or understand quickly; and he will share with the new engineer every proper record

of operation which he himself would desire to have in taking charge of the installation. If the new man desires to make a list of all machinery sizes, such as cylinder diameters and strokes, capacities of pumps, heads and pipe sizes, he will throw open his notebook for his benefit and will permit blueprints to be made of tracings which he may have, besides explaining freely the manner of operation of any home-made labor-saving or other devices for enhancing economy of operation for which he may have been responsible.

He will share the results of tests and will post his successor, so far as the latter shows himself a suitable person to be posted, upon the general policy of the organization regarding purchases of fuel and supplies, the treatment of inspectors and public officials, and the existing division of responsibilities among his subordinates. The wise engineer will consistently avoid personalities, however, either in speaking of his superiors or of those under him, and thus will leave the incoming engineer free from prejudices and in a position to form his own judgments of his associates. If a man can make himself grant this sort of coöperation with an utter disregard of his own personal likes and dislikes in relation to those above and below him, he deserves to be classed among the thoroughbreds and listed as a master of his own personality, no less than of his highly technical and responsible profession.

The Engineer's Training

It is a much discussed subject whether a technical education and training really pay the engineer. A man who has acquired his knowledge in the shop or power plant from the ground up is frequently of greater value to his employer than a man of equal degree of intelligence who has spent the same time in acquiring a technical education and passing through that period of employment during which he finds that his knowledge must in great part be forgotten and knowledge of the system and practice of his employer acquired in its stead. At some period in the development of the two men their value to those for whom they work will become equal, after which the trained man may or may not outstrip the other. If the engineering ability of the technically trained man has been made sufficiently subservient to his new environments, and his conceptive faculties thereby dulled, it still remains an open question whether the other man may not finally outdistance him. Should his engineering ability remain unimpaired and during his practical training should he have been able at times to take the initiative, he will probably grow much more valuable to his employer than the man trained entirely in the shop or plant.

The large manufacturers fully realize this, as is evidenced by the number of technically trained college men to whom they give employment each year, but this does not alter the fact that the natural effect of employment by a manufacturer is to lessen the engineering ability of the trained engineer. A doctor's assistant who had spent, say some seven years in assisting a surgeon in amputating limbs and finally performing the operations himself, could cut off a man's arm more efficiently and satisfactorily than a young doctor who had just completed his seven years training, but if treatment was required for a sprained wrist, for instance, the sufferer would probably prefer to go to the young doctor than to trust to this specialist in limb removal. Even the employer of the assistant would probably choose the young doctor to help in a case not identical with the assistant's regular duties.

The engineer's livelihood depending upon his ability to make good, his responsibilities are great and his place in the modern industrial world important. Economy and efficiency are impossible without his applied knowledge and it seems strange that his economic value is not more generally recognized. To be a consulting expert, the engineer need not necessarily be a college-bred man, as in almost every other profession, but the college man ordinarily has the advantage, for without definite and legal requirements for the right to pass as an engineer some standard must be adopted. An engineering degree conferred by a technical school of repute naturally carries considerable weight. No such degree can be obtained from a technical school of recognized high standing without the recipient acquiring at least a knowledge of the principles of good engineering. Though engineering is but "good horse sense" and can be acquired without going to college, the man *not* trained in a technical school must have a past record and his experience must have been general and more exacting than that of the college man, in order to develop to the same degree those powers of perception and resourcefulness afforded the college man by his technical training—a technical education at college being but a short cut for developing powers of perception and ability to diagnose correctly.

Hands Off!

Again the politicians seek to interfere with the work of a semi-engineering department well and efficiently conducted.

The work of Lewis T. Bryant, Commissioner of Labor for New Jersey, is looked up to by many authorities as most commendable.

The New Jersey Labor Department has to do with factory inspection, which includes hygiene, building and electrical inspection, and the enforcement of the child-labor law. It must also enforce the recently enacted engineers' license law.

Governor Fielder has retained Mr. Bryant, and the cheap politicians are uneasy. The Economy and Efficiency Commission, authorized to probe the affairs of state departments, apparently seeks to discredit and embarrass Commissioner Bryant, and plans to wipe out his department by combining it with the department of Statistics of Labor and Industry, with the intent, perhaps, of procuring soft berths for some of its friends. It is the same old story, and another example of why such a department should be severed from political influence.

The Bureau of Engineers' Licenses is a part of the Labor Department. This bureau is yet to be organized, its rules formulated, and the work correctly begun. Commissioner Bryant may be depended upon to do this rightly. The engineers of New Jersey have protested against unfair treatment of the commissioner, and we are glad to voice our protest with theirs.

An efficiency commission should seek to promote good work when done efficiently. When its aim is otherwise, it must be made to keep its hands off.

The report of the Standard Oil Co., of California, shows an increase in net earnings for 1913 over 1912 of 172.8 per cent., which explains the necessity of increasing the price of oil and gasoline.

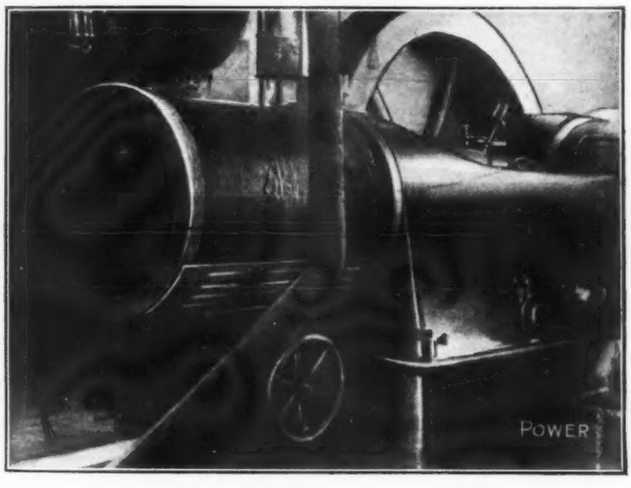
Correspondence

Piston Knocks Out Cylinder Head

A 375-hp. engine, part of the equipment of the Charles City Lighting & Heating Co., Charles City, Iowa, was recently put out of service temporarily by a serious breakdown. The piston, piston rod, cylinder and cylinder head were damaged beyond repair.

At the time of the accident the engine was well loaded. Apparently the piston rod broke flush with the nut holding the piston on the rod, just as the crank was at its outer center.

The head and cover were thrown against the head of a second engine, smashing the cylinder-head cover, but,



Cylinder of Wrecked Engine

fortunately, the head was struck near the edge and was not seriously damaged.

The piston rod, except where it broke, the guides, connecting-rod and the crankpin were not sprung or damaged. This indicates that the piston-rod nut broke off just as steam was admitted behind the piston and that the piston was blown off the rod with sufficient force to knock off the cylinder head. There was no indication that any substance had gotten between the piston and the cylinder head.

The piston left the cylinder at an angle and struck a glancing blow against the brick wall of the boiler room. An irregular piece was broken from the edge or corner of the piston. A small crack extended out from the piston-rod hole. It had been known for some time that the piston was cracked at this point and a new piston was to be put in soon. Possibly this crack allowed a slight looseness which caused the rod to break flush with the piston surface.

The cylinder head was not badly damaged. It was evidently blown off squarely, breaking all but four of the studs. The nuts must have split on these four, for the studs were quite straight and the threads but little bruised. The cylinder was cracked about 10 in. longitudinally.

Fortunately, no one was seriously injured. The engineer's hand and arms were cut by glass from a window into which he ran, mistaking it for a door in the darkness.

It is remarkable that there were none seriously injured, as the men were accustomed to pass the end of the damaged engine frequently and often stood near it, because the steam gages and switchboard were easily seen from that position.

C. V. Hull.

Charles City, Iowa.

Steam Gage as Water-Level Indicator

An interesting instance recently came to the writer's notice. There had been a mercury-indicating column in the engine room to show the water level in the tank on the roof, but the glass was broken, all the mercury was lost; and the proprietor refused to buy more. The engine-room force was informed that it would have to go to the roof to see the water level. This soon grew intolrable with five flights of stairs to climb, so an indicator was devised.

An abandoned steam gage was connected to the bottom of the ¼-in. pipe which led to the tank. The fireman was sent above to signal by tapping on the pipe for every foot the water should fall. A cardboard disk had been inserted over the dial face in the gage. Accordingly the engineer marked the various points indicated by the pointer on the disk at the fireman's signals. The gage then indicated the water level.

Edward T. Binns.

Philadelphia, Penn.

Hot Feed Water Caused Pump Trouble

The operation of our boiler-feed pump had not been satisfactory for some time, it having a tendency to race and pound several times a day; sometimes after this occurred it would stick. The conclusion was that this trouble was caused by wear and the outfit was overhauled, but the trouble was still there. As the work had been done by a most reputable machinist, we felt it was not the fault of the pump.

Then it was decided to study local conditions. The pump is in the boiler room and is supplied with water from an open heater, in the engine room, about 100 ft. away. The heater was originally placed near the engine so as to keep the back pressure down. The water level in the heater is about 8 ft. above the pump suction and the 2-in. suction line contains six elbows. We carry 90 lb. boiler pressure and have a back pressure of 10 lb. on the pump. The exhaust pipe goes up from the pump to

provide head room and so forms a trap for condensation. A pet-cock was put in this pipe, and was just cracked, but while this helped it did not remedy the trouble.

The feed water ranges from 200 to 212 deg. The piping had recently been changed and the exhaust from one of the engines, which had formerly been wasted, was sent to the heater. The idea was that the 8-ft. drop would force the water to the pump suction and it was wanted as hot as possible. The 100 ft. of pipe and the six elbows are the equivalent of 250 ft of pipe. Pumping 25 gal. of water per min. the loss is 3 ft. per hundred, or a total loss of 7½ ft., leaving but ½ ft. to cause a flow to the heater. Water at 212 deg. temperature can be vaporized by reducing the pressure a fraction of a pound, and without the addition of external heat. This was what was happening.

The gravity head and the pipe friction were almost balanced. The pump made a stroke slightly faster than the average and the suction lift was increased. The water could not flow faster and the extra pull created steam or vapor. The trouble was remedied by removing one of the shelves in the heater, thus keeping down the temperature of the water. This could also have been done by bypassing part of the steam to the atmosphere.

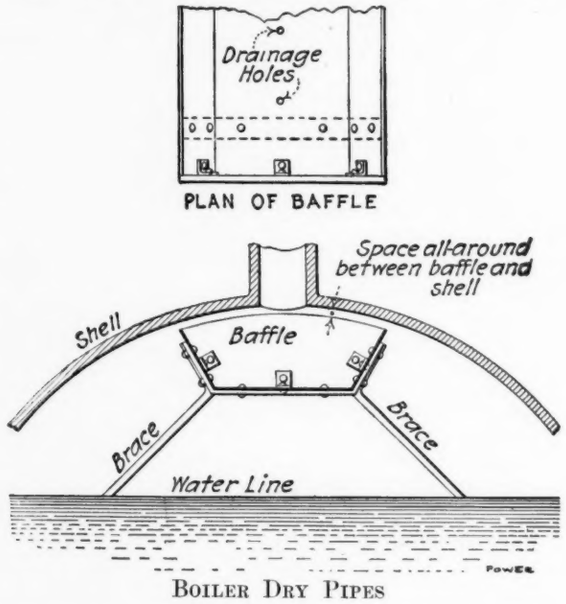
The pump is again operating most satisfactorily, and the lesson has been learned that hot water must flow to the pump and will vaporize if the slightest pull is given over the vaporization point on the temperature-pressure curve.

H. C. WIGHT.

Philadelphia, Penn.

Boiler Dry Pipes

The construction of the dry pipe shown by Mr. Everett in the Dec. 23 issue is different from any that I have seen in that the caps are screwed on water-tight. Usually the



BOILER DRY PIPES

end of the pipe is closed by a loosely fitting head which leaves space for drainage.

Another kind of dry pipe is made of heavy sheet iron with the ends capped, the upper side slotted the entire length, and having several small holes in its lower side for drainage. The current of steam passing through these holes at the bottom would be so small that it would have no tendency to lift the water. When a boiler is priming badly, water will be carried over into the dry pipe, even though there are no holes in the bottom. This water must either be drained out or go over with the steam, defeating the purpose of the device. I doubt very much if the water in the dry pipe would be evaporated. A few small holes in the bottom will at least do no damage. I consider Mr. Everett's pipe a good one, and believe that the drain holes should be left open.

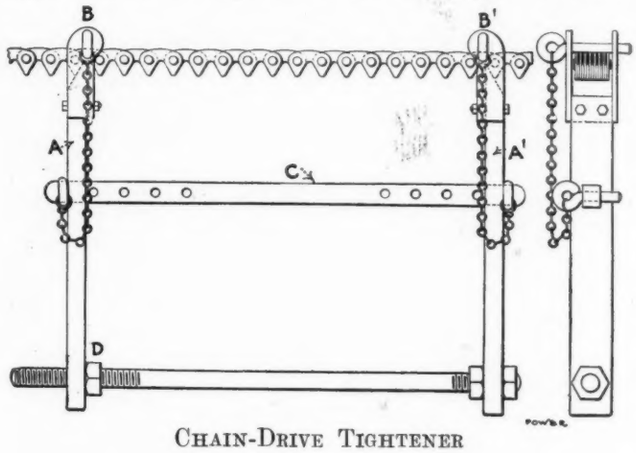
Once I had two boilers, located at the end of the header nearest the engines, which primed badly at times of heavy load, and sometimes the water would fluctuate 8 or 10 in. in the glass. The illustration shows the design of a baffle which largely corrected these conditions.

J. C. HAWKINS.

Hyattsville, Md.

Chain-Drive Tightener

A handy tightener is shown in the illustration. The jaws of the bars *A* and *A'* fit between the links of the chain, and are held in place by pins *B* and *B'*. A square



CHAIN-DRIVE TIGHTENER

rod *C*, with pins in each end, keeps the bars *A* and *A'* from spreading, and several additional holes allow for adjustment. When the nut *D* is screwed out toward the end of the rod, all the slack in the chain is brought between bars *A* and *A'*, so that the required number of links may be removed with ease. The pins on each end of the tightener are attached with chains to keep them from being lost.

LAWRENCE KJERULFF.

Kansas City, Mo.

How to Buy

One of the essential qualifications of the successful engineer is good judgment in purchasing equipment and supplies. As an example of what not to do, let us assume that the engineer is in need of a steam separator, and after looking at the different makes, he selects one with regard to price and construction.

When he receives the separator, to his surprise there are no companion flanges, bolts, drain valves or glass gage with it. The manufacturers' catalogs show a picture of the separator with all the fittings attached, but nothing is said about the trimmings and the purchaser has assumed that they are included. When the trimmings

must be bought later the "boss" investigates and finds that at least some separators are so furnished, as they should be, the engineer is criticized, and the buying thereafter is closely watched or is taken away from him entirely, and he has fallen a point in the estimation of his employer. Other things, too numerous to mention, could be used as well to illustrate the same point.

Let us, as engineers, so educate outselves that we can do the purchasing ourselves, or be able to give concise information in our line. Manufacturers are at all times willing to send catalogs and answer questions regarding their products and it is "up to us," when our employer asks us "Why?" and "How?" to let him know that we are on the job and know our business. It may also put a few more dollars into our pay envelope.

Kansas City, Mo. HOWARD G. SCHULER.

Scientific Management

We are entertained in POWER, from time to time by contributors, and by editorials, with questions, opinions and even ridicule about the operating engineer.

The editorial, "One-sided Development," in the Aug. 19 issue, asserts that the operating engineer is underpaid because he has not acquired the business ability needed to sell his services at their real value.

One correspondent goes so far as to feel justified in thinking that anyone must be mentally deficient, who works such long hours for inadequate pay. The point of view which inspires this criticism is one-sided or idealistic; it is based on conditions as they should be.

The dictionary's definition of "engineer" is true only theoretically. To the majority of power-plant owners and managers, the engineer is simply the man who keeps the wheels turning around, and it will be some time before they realize that an engineer may be more than a mere starter and stopper—that he may be instrumental in increasing the profits of the establishment.

If it is necessary to educate the engineer along professional lines to render him capable of estimating the value of his services, it is likewise necessary to educate the power-plant owner to safeguard his interest by engaging the services of a competent engineer.

The engineer will educate himself readily enough if he sees that competence as an economic engineer is at a premium, and that his position is jeopardized by lagging behind. On the engineers' part, it is only a question of demand. When competent engineers are in demand, there will be men who will qualify themselves to supply the need.

In the education of employers and managers a different element enters. It is hard to believe, but nevertheless, there are employers, who are so autocratic toward their employees, that they will permit even easily preventable losses to continue, rather than ask or accept economical suggestions, indicating that if there are any changes made they will be the authors thereof. They will say to him, who has the temerity to offer advice, "Never mind your brains; let's see your muscles."

Employing incompetent engineers is due to ignorance of the possibilities of economical management of the steam plant. It is only recently that the beneficial results of scientific management—even in unloading a car of pig iron—were made public, and it has created the intended impression on the minds of those who are responsible for the annual dividends.

It is detrimental both to the interest of the engineers and that of the owners, that managers, in many instances, assume, perhaps justly, that an engineer's license is not a certificate of competency; that it is acquired without merit by the holder.

It is easy to advise the engineer to quit his job and go to digging ditches, in order to retain his self-respect, where the management does not treat him deservedly.

Why does the average beginner drift into the boiler room? Because as a fireman, he can make a few more dollars than he would at common labor. He is paid a couple of dollars more, not because the management thinks that the job requires more intelligence, with apologies to the opinion of the minority, but because it is hard work and long hours. He takes the job, because after he becomes familiar with his work, he is practically his own boss. After some years he gets his license, where one is required, or is simply promoted to run the engine, with a little raise in pay. It is only too true that the promotion is usually due, not to possessing the attributes of an engineer of dictionary definition, but because he is willing and obliging, a handy man, etc.

I believe that the majority of these men are progressive, and are perfecting themselves along professional lines; it would be expecting too much for them to go back to the pick and shovel for idealistic reasons only.

In holding down their jobs until there are better places open, they are only following the examples of men of larger importance, who if they were to relate their experiences, would undoubtedly say that they had to be content with an inferior, underpaid job long after they were competent to fill their present positions. There are also many competent, deserving men who never attain the position to which their ability entitles them, notwithstanding the assertion that merit and will power only are necessary to succeed.

New York City. VICTOR BONN

Standing Charges

In reference to an article of Ralph E. Somers, of New York City, appearing in POWER, Feb. 10 issue, page 204, under the head "Power-Plant Conditions in the South," in the third paragraph he states that the standing charges against a steam plant are 12 per cent.

I would like to ask him how he arrives at this figure, or in other words, for an itemized statement of the factors which make up this figure.

J. MCL. JONES.

Charlotte, N. C.

I said that the standing charges "are usually *assumed* at *about* 12 per cent."

Interest	5
Depreciation	5
Taxes and insurance	2
	12

If interest is 6 per cent., depreciation 6⅔, as Reginald P. Bolton wants to charge it on page 180 of the issue of Feb. 3, and if taxes and insurance are a little higher it may be 15, which would make out a worse case for the hydroelectric plant.

New York City. RALPH E. SOMERS.

Engineers' Study Course

Curve Plotting--II

The last lesson showed that any point may be represented by two numbers, called its coördinates, usually written (x, y), or any two numbers may be represented by a point. It is also possible to represent any equation in x and y by a curve or group of curves, but not all curves are capable of being represented by equations, although the simple ones can be. The two unknown quantities (or *variables,* as they are called) in the equation need not be represented by x and y; an equation in u and v or any other letters, would do just as well, but then instead of calling the axes those of x and y, we simply call them those of u and v.

To plot a curve from its equation, we assume various values for one variable, and find what the other variable will equal under those conditions. For example: To plot the equation, $y = 3x + 4$, we make a table as follows:

If $x = -3$ $y = -9 + 4 = -5$
$x = -2$ $y = -6 + 4 = -2$
$x = -1$ $y = -3 + 4 = +1$
$x = 0$ $y = 0 + 4 = +4$
$x = 1$ $y = 3 + 4 = +7$
$x = 2$ $y = 6 + 4 = +10$
$x = 3$ $y = 9 + 4 = +13$

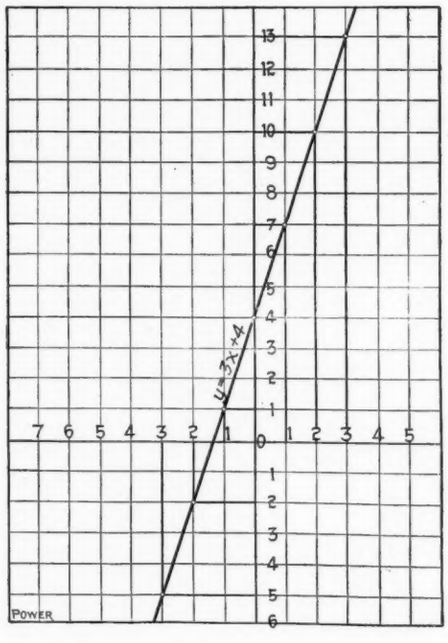


FIG. 3. STRAIGHT LINE

If we now lay off on cross-section paper the points $(-3, -5)$, $(-2, -2)$, $(-1, +1)$, $(0, +4)$, $(1, 7)$, $(2, 10)$ and $(3, 13)$ and connect them we have the curve represented by this equation, in this case a straight line,* Fig. 3. That is, to plot an equation, we assume values for one of our unknown quantities, find the values of the other unknown quantity corresponding to the first, mark off the points corresponding to them and connect them.

There are one or two special cases. The equation $x = 4$, means $x = 4$ for any and all values of y. That is, this is a line parallel to the axis of y, and 5 units from it. Similarly, $y = 3$, represents a condition that $y = 3$ for any and all values of x, which is fulfilled by a line parallel to the axis of x, and three units from it.

However, these are, as said, special cases, and in general any equation of the first degree can be reduced to the form

$$y = mx + b$$

m and b representing any two constant numbers. This is the usual form in which the equation of a straight line

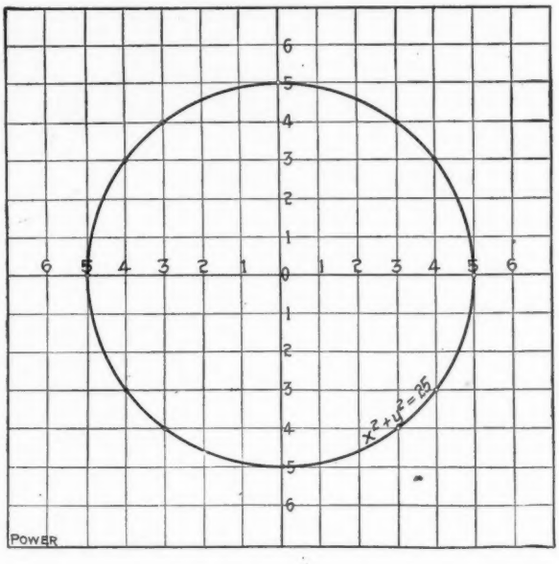


FIG. 4. CIRCLE

is written, and has this convenience, that m, whatever number it is, is the tangent of the angle the line makes with the axis of x, and b, whatever number it is, is the distance from the center O, that the line cuts the axis of y. For instance, the equation

$$4y = 3x + 7$$

can be written

$$y = \frac{3x}{4} + \frac{7}{4}$$

and this particular equation could be immediately plotted by taking a distance $\frac{7}{4}$ out on the axis of y, and drawing a line through this point making an angle with the axis of x whose tangent is $\frac{3}{4}$.

Another way in which equations of the first degree can always be written is:

$$\frac{x}{a} + \frac{y}{b} = 1$$

The same equation

$$4y = 3x + 7$$

reduces to

$$\frac{y}{\frac{7}{4}} - \frac{x}{\frac{7}{3}} = 1$$

or in the above formula $a = -\frac{7}{3}$, $b = \frac{7}{4}$.

*Every equation in which x and y are found only in the first power represents a straight line.

In this form of writing the equation, a and b are the distances from the center on the axes of x and y, where the straight line cuts these axes. These distances are known as the *intercepts* on the axes of x and y.

Knowing this much about the straight line, we can find the equation where we have the line. Suppose a straight line passes through the points (4, 2) and (—5, 3). Let us find the equation in the form

$$y = mx + b$$

When $x = 4$, $y = 2$; when $x = -5$, $y = 3$ therefore,

$$2 = 4m + b \quad (1)$$
$$3 = -5m + b \quad (2)$$

Subtract (2) from (1) $-1 = 9m$, or $m = -1/9$;
Substituting in (2)

$$3 = \tfrac{5}{9} + b, \text{ or } b = \tfrac{22}{9}$$

Then the equation of a line passing through points (4, 2) and (—5, 3) will be

$$y = -\tfrac{1}{9}x + \tfrac{22}{9}, \text{ or } 9y = -x + 22$$

The matter becomes a little more complicated when the equation is quadratic, i.e., contains squares of x and y.

Suppose $x^2 + y^2 = 25$, then

If $x = 0$,	$y = \sqrt{25} = 5$	$x = 5$,	$y = \sqrt{0} = 0$
$x = 1$,	$y = \sqrt{24} = 4.9$	$x = -1$,	$y = 4.9$
$x = 2$,	$y = \sqrt{21} = 4.6$	$x = -2$,	$y = 4.6$
$x = 3$,	$y = \sqrt{16} = 4$	$x = -3$,	$y = 4$
$x = 4$,	$y = \sqrt{9} = 3$	$x = -4$,	$y = 3$
		$x = -5$,	$y = 0$

If we plot the points corresponding to these values, and connect the points, we find we have a circle, as in Fig. 4. In general, any equation of the form $x^2 + y^2 = r^2$

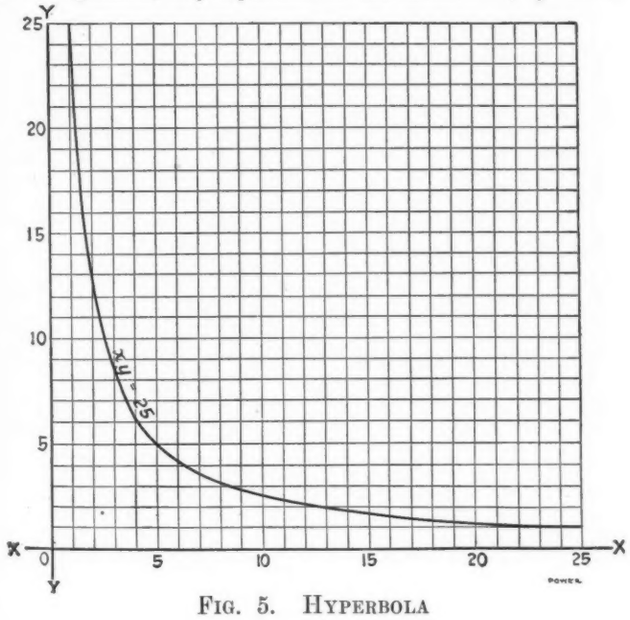


FIG. 5. HYPERBOLA

is a circle of radius r. (In the above example the radius is $\sqrt{25} = 5$.

If we take the curve $pv = 25$, then when

$p = 10$	$v = 2.5$;	$p = 5$	$v = 5$
$p = 9$	$v = 2.78$;	$p = 4$	$v = 6.25$
$p = 8$	$v = 3.13$;	$p = 3$	$v = 8.33$
$p = 7$	$v = 3.57$;	$p = 2$	$v = 12.50$
$p = 6$	$v = 4.17$;	$p = 1$	$v = 25$

If we plot this curve, measuring the "p's" on the axis of y, and the "v's" on the axis of x, we obtain a curve which represents the behavior of steam as it expands, or air as it is compressed, without change of temperature. (The engineer will immediately recognize this as a part of his indicator diagram.) It is a part of a curve known as an *equilateral hyperbola*, and the rest of the curve may be obtained by plotting:

$$p = -10 \qquad v = -2.5$$
$$p = -9 \qquad v = -2.78 \text{ etc.}$$

(The minus branch has no physical meaning.)

Fig. 5 is an hyperbola, a plot of an equation of the form $xy = 25$.

In like manner we may plot any equation, by making a table of values of y corresponding to various assumed values of x, finding the points corresponding to each pair of values, and passing a straight or curved line through these points.

We can summarize much information concerning the simpler equations. Every equation of the first degree is

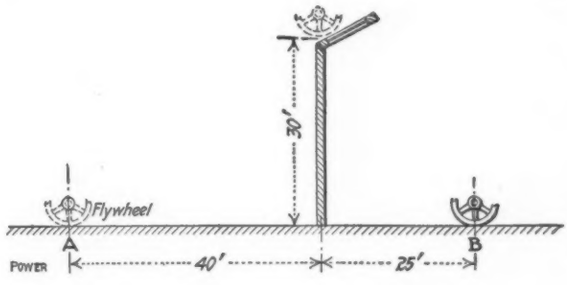


FIG. 6. PROBLEM OF BURST FLYWHEEL

a straight line. Every equation of the second degree is either a circle, an ellipse, a parabola, a hyperbola, or a pair of straight lines.

Any equation of the form $y = mx + b$ represents a straight line in which m is the tangent of the angle between the line and the axis of x, and b the intercept on the axis of y.

$$\frac{x}{a} + \frac{y}{b} = 1$$

is a straight line where a and b are the intercepts on the axis of x and y respectively.

$$x^2 + y^2 = r^2$$

is a circle, whose center is the point O, O, and of radius r.

$$(x - a)^2 + (y - b)^2 = r^2$$

is a circle, whose center is the point a, b, and of the radius r. (The simpler equation may be derived from this by putting $a = o$, $b = o$)

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

is an ellipse, with O, O as the center, and a and b as semi-diameters.

$$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$$

is a hyperbola, with the axes of x and y as its axes.

$xy = a$ is an equilateral hyperbola, with its axes at 45 deg. to $X'\,OX$ and $Y'\,OY$.

$y^2 = kx$ is a parabola, whose axis is $X'\,OX$.

Now, what is the good of all this? Can any problems be solved by it which are not easily solved otherwise? Here is an elementary one which is more easily solved by plotting equations than in any other way.

Suppose, as was an actual case, a flywheel burst at B, Fig. 6, a piece just cleared the wall 25 ft. away, 30 ft. high (it actually went through a skylight) and alighted 40 ft. farther off. How high did it go?

Bodies thrown into the air travel in parabolas, and the highest point is midway from A to B. We draw our figure then, as in Fig. 7.

The parabola is of the form $x^2 = -ky$. By the conditions of the problem, the parabola goes through point B $(32.5, -y)$ and through C $(7.5, -y + 30)$. (Try to see how those coördinates are obtained). Then

$$32.5^2 = +ky \quad (1)$$

$$7.5^2 = k(y\,30) \quad (2)$$

Solving by dividing (2) by (1)

$$\frac{7.5^2}{32.5^2} = 1 - \frac{30}{y}$$

which gives

$$y = 5\tfrac{0}{16}\tfrac{7}{}, \text{ or } -y = -5\tfrac{0}{16}\tfrac{7}{}$$

That is: the wheel at its highest point was $31\frac{11}{16}$ ft. off the ground.

Other applications are: If two simultaneous equations are given, as

$$x + 3y = 16$$

$$x^2 + y^2 = 36$$

an approximate idea of the solution may be had by plot-

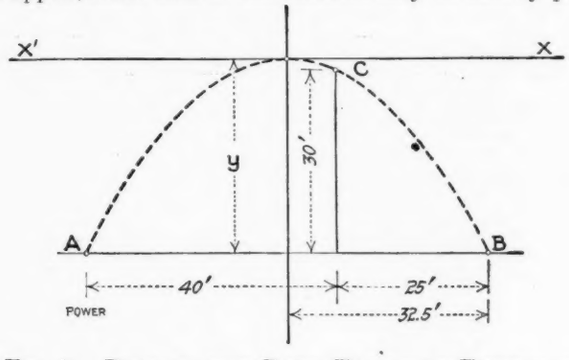


FIG. 7. PLOT OF THE PATH TAKEN BY FLYWHEEL PIECE (PARABOLA)

ting these equations. The intersections of their graphs are the solutions of the simultaneous equations.

Or, in the equation

$$x^3 - 2x^2 + 3x - 4 = 0,$$

if we put

$$y = x^3 - 2x^2 + 3x - 4,$$

and plot the graph, we can get an idea of the approximate roots of the equation, as these will be where the graph crosses the x axis.

If $x = -5$,	$y = -194$	$x = 0$	$y = -4$
$x = -4$	$y = -112$	$x = 1$	$y = -2$
$x = -3$	$y = -58$	$x = 2$	$y = +2$
$x = -2$	$y = -26$	$x = 3$	$y = +14$
$x = -1$	$y = -10$		

There is a root between $+1$ and $+2$, and by computing between these points we can approximate it as closely as we please.

⁂

Miners' and Mechanics' Institutes—At a recent meeting of the board of trustees of the University of Illinois, R. Y. Williams was appointed director of the Miners' and Mechanics' Institutes, which are to be established under the direction of the department of mining and engineering. Authority for the establishment of these institutes was granted by an act of the state legislature in 1911, but no appropriation was made to carry out the authorization until the latter part of the recent session of the legislature, at which time an appropriation of $15,000 per annum was made. The purpose of the Miners' and Mechanics' Institutes is somewhat similar to that of the Farmers' Institutes, but their specific purpose is to assist men who are preparing themselves to pass the tests required by the state before they can hold official positions about the mines.

OVER THE SPILLWAY

JUST JESTS, JABS, JOSHES AND JUMBLES

That we should bibble about the income tax! Think of all the worry (and the collectors) we escape; the dignity we don't have to support; the jealousy and sneers we don't excite. Great, ain't it, not to be forced to accept a three or a four thousand-dollar salary? Just plain "wages" for you and me, Ignatz. And yet there are times—

⁂

This from the "Scientific American," which is as versatile as it is scientific: "It has been advanced by persons in a position to know that the styles in ladies' corsets exert a marked influence upon the design of automobile upholstery. One style of corset, in vogue today, may encourage a luxurious lolling position of the wearer, another style, in vogue tomorrow, may compel a severely upright position. Consequently designers find it incumbent to study other things besides automobile engineering."

Keep this item to yourself. If your wife sees it, she'll get dissatisfied with her present car.

⁂

"You can never eliminate the human element," declares the president of Yale. All the more credit, then, for the Pennsylvania System, which states that "not a single passenger out of the 111,000,000 carried in 1913 was killed in a train accident."

⁂

The following trickles into the Spillway from "Constant Reader," and we reprint it as a mark of esteem for the engineering knowledge of the young lady who thus describes the building of a locomotive:

"You pour a lot of sand into a lot of boxes, and you throw old stove-lids and things into a furnace, and then you empty the molten stream into a hole in the sand, and everybody yells and swears. Then you pour it out, and let it cool, and pound it, and then you put it in a thing that bores holes in it. Then you screw it together and paint it, and put steam in it, and it goes splendidly, and they take it to a drafting room and make a blueprint of it.

"But one thing I forgot—they have to make a boiler. One man gets inside and one gets outside, and they pound frightfully; and then they tie it to the other thing, and you ought to see it go!"

⁂

An American engineer in Cuba tells the following:

"One time, while trying to start a refractory gas engine whose igniter was out of order, I managed to fire an accumulation of gas in the muffler pot with the result that would shame a 12-in. gun. The panic among the factory hands was more than funny. They did not wait to use the doors but went out through windows and every crevice that would allow a man to pass, and then kept on going for some time. The mechanic in charge proved to be the best sprinter, as he did not stop until he reached home. Later he sent a man around to get his coat and dinner-pail, with a message that he was a mechanic, not a gunner."

⁂

Our friend Charley Johnson, out Minneapolis way, sends us this clipping:

"A. C. Rutzen declared he has perfected a spring motor that will transmit power in abundant quantities; Rutzen says his invention comprises sixteen high-powered springs, fifteen of which give forth power while one is perpetually being rewound. The model is high and twenty-two inches wide. Twenty electric lights from power generated have been giving forth a steady glow for nearly a year."

⁂

And Charley suggests that we "notify the engine builders to stop manufacturing before it becomes necessary to appoint a receiver; any one can see at a glance that the steam engine will be a thing of the past. The power plant of the future will consist of 'sixteen springs' 'neatly packed in a hardwood case ready for use', sent anywhere in the United States upon receipt of price. I don't believe it is advisable to exploit this too heavily, as some of the fraternity who have not as yet been run on an open throttle might try to make an engine and only use 15 springs, and the consequent short-circuit might be more than their crankshaft can stand."

Power Plant Changes Save Coal*

By Warren O. Rogers

SYNOPSIS—An engineer upon taking charge of a steam plant found a miscellaneous collection of engines and traps, and old-time methods in vogue. All but one of 14 traps were dispensed with, and five steam engines and five of nine steam pumps were discarded. A 100-kw. generator was belted to the main engine to carry the electrical load, by using a simple drive system, although several consulting engineers said it could not be done.

When the new engineer assumed charge of the steam plant of the Blank Manufacturing Co. he found that two 72-in. by 18-ft. and one 78-in. by 20-ft. return-tubular boilers were required to supply steam to six engines of various horsepower and design. Two of those engines were directly connected to direct-current generators. Nine

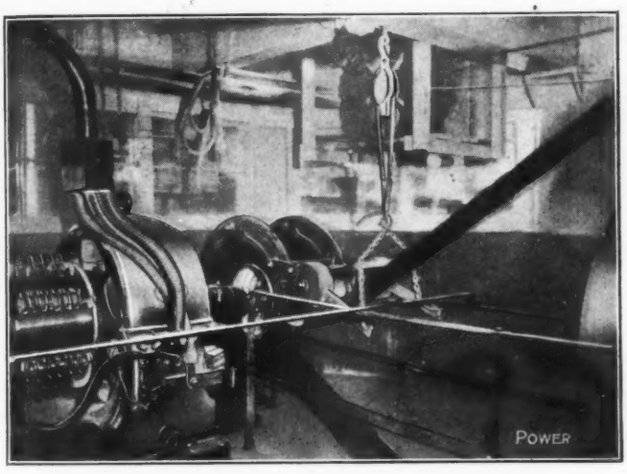


Fig. 1. Application of the Lenix Drive

pumps, of miscellaneous types, were also doing their share in consuming steam. As his eyes traversed the boundaries of the engine room he discovered 14 steam traps for handling the return from various heating coils and machinery used in the mill.

After familiarizing himself with his plant and the work of the mill the engineer returned to his office to think. He concluded that if matters were allowed to continue, the plant would be a good proposition for the central station, at almost any charge for electrical energy, and still be an inducement for the owners to change from their own power to central-station service.

Engineer "Wise" did more than think; he put on his overalls and jumper and went to work. It was a puzzle just where to begin, but a start was made in the boiler room, where a forced-draft fan blower was driven by a 40-year-old 8x10-in. vertical engine. The engine-driven generators were underloaded and a motor-driven fan appealed to Engineer "Wise." To be on the safe side the makers of the fan were consulted regarding the size of the motor necessary to drive the fan. Sixty horsepower was recommended and "Wise" felt faint. After duly considering the matter a 15-hp. motor was placed on a shelf in the boiler room and belted to the pulley of the 36-in. diameter, 22-in. face, blower. The motor drives it at 600 r.p.m., and produces ample air pressure for the boiler furnace.

The traps and piping system, which appeared complicated and, in most instances, unnecessary, were studied. The returns from the factory came back to traps which discharged into a receiving tank, from which the water was pumped through the heater to the boilers. The discharge of water and steam into the receiving tank was responsible for nearly as much steam escaping to the atmosphere, through a 3-in. vent pipe, as came from the engine exhaust, after heating the feed water. To prevent the escape of steam from the vent pipe it was the practice to admit cold water to the receiving tank, and all excess water not used for boiler feed ran to the sewer through the overflow pipe; a useless waste in both cases.

"What is the use of those traps," thought Engineer "Wise," and out they came. The high-pressure returns from presses, heating table and other sources were connected to one pipe, which discharged into the blowoff pipe of each boiler. But one trap was retained, which handles the low-pressure drips. This saved the steam and water that had been allowed to go to waste from the receiving tank, also the steam used to operate the traps.

At one side of the factory there was a reservoir for storing water used about the works. The water was pumped from a well to the reservoir, and from the reservoir to a tank on the roof and to a water-softening system. From the water softener the water ran to the return tank by gravity. The water softener was discarded as useless, and water from the well is now pumped to the return tank for the makeup water as required, also to the factory water piping, the pump being automatically controlled.

Out in the factory a 20x48-in. Corliss engine drove two sets of rolls, and was greatly underloaded. Engineer "Wise" conceived the idea of driving a 100-kw., 125-volt generator from this engine and shut down the two engine-driven generators in the other engine room. The Corliss engine had a 14-ft. flywheel with a 13-in. rim face. The engine room was restricted in floor space, and placing the generator with a 22-in. pulley, in line with the engine flywheel, would give about 14-ft. centers, which, with the ordinary drive, would not be practical.

Several consulting engineers were called on to solve the problem. One advised putting the generator out in the yard and housing it in, using a long belt drive. Another advised setting up a countershaft out in the yard and belt from the engine to it and from the countershaft back to the generator, placed alongside of the engine cylinder.

Engineer "Wise" was not satisfied with any of the propositions submitted and insisted on some kind of a drive that would allow placing the generator in the engine room. The general verdict was, however, "It can't be done."

"That does not go here," said "Wise," and started on a hunt for an engineer who could install a drive that would permit of placing the generator in the engine room at the crank end of the engine. In his search for help he took the matter up with F. L. Smidth & Co., of New

*The changes were made in a Brooklyn plant, and the incidents recorded herewith actually occurred.

York, who solved the difficulty by installing a Lenix drive, as illustrated in Figs. 1 and 2. This drive consists of a cast-iron base on which a semicircular arm is pivoted at one end. At the other end is an idler pulley and shaft which runs in bronze bearings. At the pulley end of the idler arm two weight-arm extensions and weights are pro-

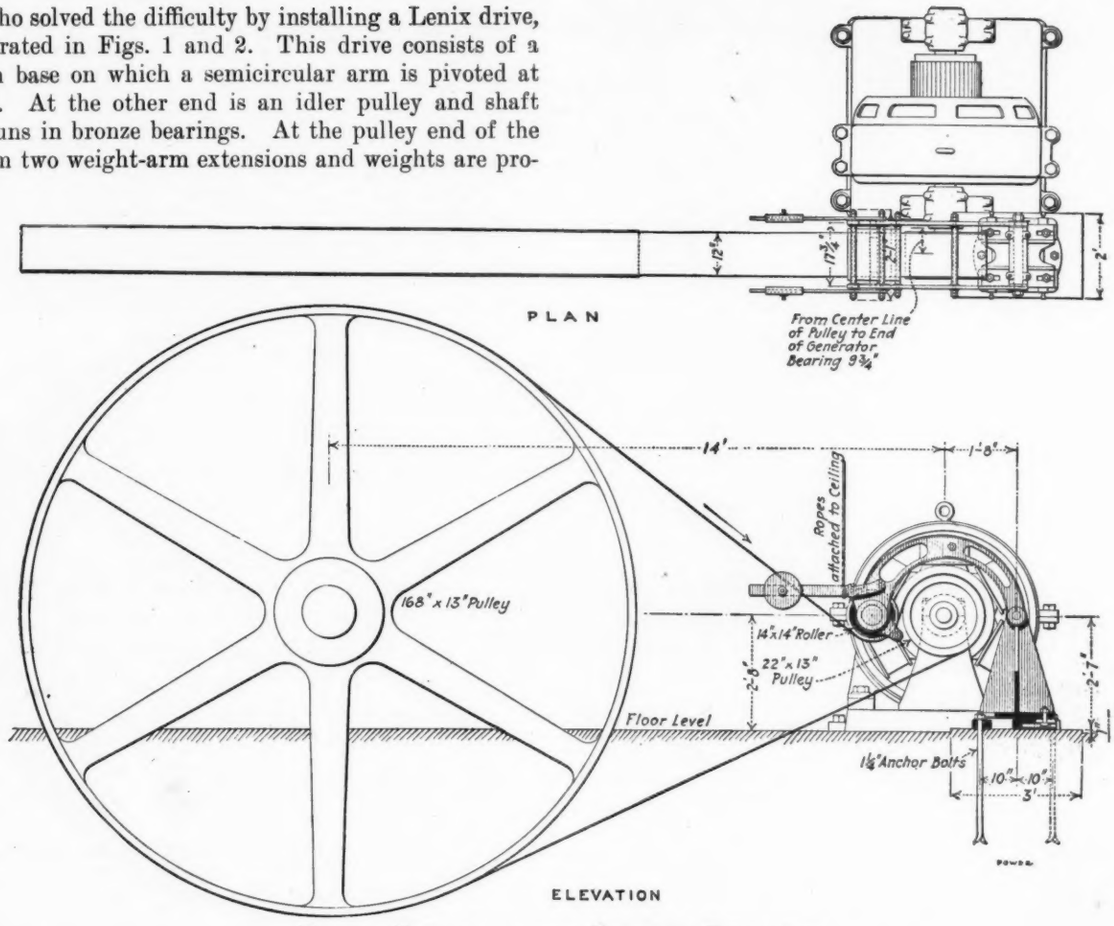


FIG. 2. DETAILS OF THE DRIVE AS INSTALLED

vided for adjusting the tension of the belt. This arrangement gave a distance between the engine and generator-shaft center of 14 ft., with a pulley ratio of 1 to 7.6. The belt is double and 12 in. wide.

With this arrangement of drive the Corliss engine now carries the factory load and the two direct-connected engines have been shut down. Besides this two vertical engines used for driving cylinder rolls have been displaced by two 40-hp. direct-current motors. This change resulted in a more uniform speed and an increased and better quality of product.

All of these combined changes necessarily affected the coal consumption. Before they were made the three boilers were used, burning soft coal at a cost of $4.15 per ton of 2240 lb. During the first week of Feb., 1910, 101,108 lb. or 45.1 long tons were burned at a cost of $187.16. Under Engineer "Wise" management, since the changes, a mixture of anthracite dust costing 25c. per ton is used in proportion of two parts of anthracite dust to one part of soft coal, the latter costing $3.95 per ton, the average mixture being $1.48 per ton.

For the first week of Feb., 1914, 26,464 lb. of soft coal at $3.95 per ton of 2240 lb. and 42,921 lb. of anthracite dust at $0.25 per ton of 2000 lb. were burned. This equals 11.8 tons of soft and 21.4 tons of dust at a total cost of $46.61 and $5.35, respectively. This makes a total coal consumption of 33.2 tons, at a cost of $51.96, or an average cost of $1.57 per ton. The difference in coal consumption for the first two weeks of the two years cited, is 45.1 — 33.2 = 11.9 tons. The difference in the

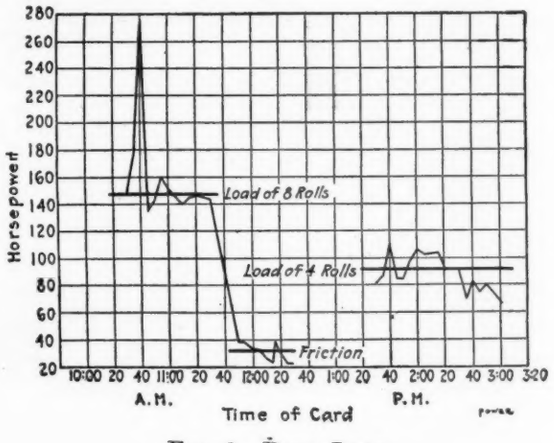


FIG. 3. ROLL LOAD

cost of coal for the same periods is 187.16 — 51.96 = $135.20 or a 36 per cent. saving.

Before the change the motor load was 250 amp., now it averages 650 amp., several additional motors having been installed in the mill.

In Fig. 3 is shown a load curve of the friction load, normal load with four and eight rolls on the engine and a peak which occurs if material is fed to the mill rolls simultaneously.

The preceding is an instance of what a wide-awake engineer can do to better plant conditions and also shows that the decision of a consulting engineer is not always the last word in power-plant practice.

Powdered Coal as a Fuel--a Review*

By Joseph Harrington

SYNOPSIS—Tells what degrees of fineness have been found best for the combustion of powdered coal. Some cost data relative to pulverizing and burning are given.

A proper intimacy of mixture of air and fuel when burning powdered coal requires that the powdered substance shall have the nature of a cloud of dust, completely and uniformly diffused, remaining suspended in the air current until burned. When in this condition every minute particle is inclosed or surrounded by a quantity of air, which is substantially that required for its complete combustion. Given a temperature sufficient for rapid ignition, a state almost ideal for perfect combustion is obtained.

Authorities are practically agreed as to the standard of fineness required for right conditions. While pulverization can perhaps be overdone, there is much more likelihood of the fuel being too coarse. A piece of coal larger than will pass through an 80-mesh screen will not burn completely in the time allowed, but will be deposited somewhere in the furnace, or pass out of the stack partly consumed.

H. R. Barnhurst states the requirements for best results as follows:

1. Coal must be dried to contain not over 1 per cent. of moisture.
2. It must be pulverized to a high degree of fineness.
3. It must be projected into a chamber hot enough to cause instant ignition.
4. It must be supplied with sufficient air for complete combustion.

Enlarging on the second requirement, he gives as a standard of fineness these figures: 90 per cent. through a 400-mesh screen; 2½ per cent. to 5 per cent. through a 200-mesh screen; the balance through a 100-mesh screen. A somewhat coarser grind is stated by A. W. Raymond as sufficient. His standard is 98.5 per cent. through a 100-mesh screen, or 91 per cent. through a 200-mesh screen for best results.

In comparing any figures of this nature it must be kept in mind that there is present in powdered fuel a certain percentage of extremely fine material, depending upon the character of the coal structure, moisture content and method of pulverization. Calibration by means of sieves establishes only the maximum size, and ignores completely the other limit. Unquestionably, however, the character of the flame is influenced materially by that uncertain quantity of impalpable dust, which gasifies instantaneously and leads the procession of combustion events.

Dry coal can be ground with about 85 per cent. of the power required for moist coal, and a condition of not over 1 per cent. moisture is required, if the fuel is to be stored or conveyed. The slightest dampness causes a balling up, and a 3 per cent. moisture content results in an actually pasty condition. James Lord states that coal should not have over 1 per cent. of moisture.

Probably the point of greatest divergence of opinion is the amount of combustible volatile the coal should contain to be suitable for burning as powdered fuel. The majority of writers seem to think that 30 per cent. of volatile matter is a prerequisite, but some report satisfactory conditions with but 20 per cent. It is evident that the higher the volatile the larger is the amount of combustible converted into gas by the mere application of heat, leaving a smaller portion of fixed carbon to burn during its flight through the furnace. Just where the limit is reached has not yet been disclosed by authentic tests.

There are two methods of firing that can briefly be described.

The process required where considerable quantities of coal are to be prepared, consists in crushing the coarser lumps so they will pass through a 1¼-in. screen in preparation for the dryer. The finer the coal coming to the plant the easier it is to both dry and mill it.

The dryer most favored is the rotary kiln discharging the dry coal to a conveyor, which carries it to the pulverizer, where it remains until fine enough to be carried away by a current of air or pass through screens of the specified fineness. It is deposited in a hopper from which it can be conveyed to any desired place. It is stored in covered bins and handled by means of screw conveyors turning in closed troughs. Not only is loss thus prevented, but the air present is not sufficient to permit of explosive mixtures. No accident of explosive nature has ever occurred to coal handled or stored in this manner.

At the point of consumption a small bunker is provided, like an inverted pyramid, having a small screw conveyor at the apex. This extracts the powdered coal as required and lets it fall into the blast pipe, where it is instantly dispersed and carried to the furnace with the air for combustion.

The second method is advocated by some, wherein the same fan used to extract the dust from the mill is also used to blow the mixture into the furnace. Again, a considerable difference of opinion exists as to the practicability of this method, owing to the amount of air considered necessary for transportation as compared to that required for combustion of the fuel.

Data relative to the cost of fuel preparation becomes of primary importance, since the entire subject is relegated to the domain of academic inquiry if economy is not obtained. The cost of the pulverization must be added to the delivered cost of the coal, which must include the usual items of total cost, such as interest, maintenance, depreciation, labor, etc. All of these figures are not available to the writer, but some analysis is possible.

Mr. Lord presented these figures to the Engineers' Society of Western Pennsylvania at Pittsburgh:

	Rate per Gross Ton of Coal Produced
Fuel	$0.034
Repairs to buildings	0.002
Operating	0.145
Power (steam and electric)	0.221
Repairs to machinery and equipment	0.200
Total	$0.602

"This total includes the cost of automatic transmission through pipes to the furnaces.

"Analyzing the last expense item, we find repairs which should be charged over the past eight years, so that the total cost of preparation and transmission did not prop-

*"Power," Jan. 13, p. 69; Feb. 17, p. 254.

erly exceed 50c. per ton of pulverized coal produced during 1912.

"If you dissociate the transmission from the actual preparation, the cost of the latter would be less than 40c. Many plants would not require the extensive transmission required by us. When the coal is prepared as herein outlined, smoke is practically eliminated."

If these costs are reduced to a basis of the short ton, we have these figures:

	Long Ton	Short Ton
Total cost	$0.602	$0.547
Same corrected	0.50	0.455
Preparation only	0.40	0.364

A. W. Raymond, in *Cement Engineering News,* gives the average cost per ton of coal ground of 14 pulverizers grinding 99.5 per cent. to 100 mesh as $0.325. This on a basis of power at 1½c. per kw.-hr.

The ash content does not affect the possibility of properly milling a coal and the lower grades of fuel can be successfully burned. A higher combustion efficiency offsetting the decreased heat value of the coal, some color is given to the claims of overall economy. Combustion experts are at work and results of interest and value may develop.

[Another article on this subject will soon appear—Ed.]

Transportation Problems of the Power Station

By T. H. Reardon

Having been identified with transportation interests, and acquainted with the hardships that beset steam-generating stations, it is from personal knowledge upon which the statement is made that transportation companies often have wanton disregard for the interests of the best class of patrons that a railroad company is called upon to serve.

Coal, from the railroad company's point of view, is "dead" freight—that is, it will sidetrack and stay anywhere until it is convenient to move it. If a power station is down flat for want of fuel, it can shift for itself, beg, buy or borrow. Following a period of congestion on transportation lines when things do loosen up, delayed traffic moves like an avalanche; there are not enough side tracks at any station to accommodate the influx and the power-station man may have 50 cars of coal on his hands at once.

Then he is notified that so many cars of coal are awaiting his further pleasure. This means that the cars would be actually trestled for unloading if the consignee was in a position to take them. The cars, therefore, go on demurrage and, after a lapse, usually of 48 hr., each car is earning $1 a day or fraction thereof it is delayed in unloading.

Of course, there is a redress if the proper course is pursued and if the consignee is familiar with red tape and transportation rulings as filed with the Interstate Commerce Commission.

As to charges for delay to cars during the unloading process, the consignee has two options: One is the regular charge, and makes allowance for inclement weather during the time of unloading, for bunching or congestion in transit and for various other matters that interfere with regularity in movement and in unloading. The other is the average agreement plan, according to which each car placed for unloading and emptied within 24 hr. earns a credit, while each car delayed over 48 hr. earns a debit. These credits and debits are balanced at the end of the month. If there is an excess of debits, the patron pays the transportation company at the rate of $1 per debit. If there is an excess of credits, however, the patron does not receive any refund. In this connection there is no allowance for inclement weather nor for congestion in transit with cars arriving badly bunched.

Then there is the local switching service at destination, the character of which will depend largely on whether the power station has service from two railroads or only one. This is an evil connected with station location and if not eliminated at the beginning it must be tolerated.

There are many other transportation problems connected with station operation, and all such should, so far as possible, be handled to best subserve the interests of the power station.

Essential to the welfare of the power station and its manifold interests is a thorough knowledge of all transportation problems. The practical way to secure this particular talent is to invade the railroad freight office and hire the most competent clerks that railroad service can furnish. Such a man would be familiar with rates, routes and classifications, special rulings, etc.

Minimum loads (a car taking a carload rate) are billed at a certain weight whether the car contains such an amount or not. Specific routing should always be furnished in giving shipping instructions to transportation companies, and a bill of lading should be taken showing this routing and the rate, prepayment class, weight and all other essential points. By neglecting these simple precautions, a shipment will often travel a long and circuitous route to further the interests of the initial carrier at an expense and inconvenience to the consignee, who can rarely obtain redress.

All bills for freight, demurrage, switching charges, etc., should be audited by men thoroughly familiar with this work. An accurate record should be kept of the time all cars are placed for either loading or unloading, and when cars remain on hand for several days, the daily record should show the car initial, number, location, and fraction of load contained, or empty, as the case may be. No freight should be acknowledged on a receipt without positively knowing that it has been received, and if in bad order its condition should be noted.

Practically all live concerns employ trained railroad clerks to protect their transportation interests. This practice cannot be commended too highly. Such men as a rule can do any class of work that comes up in the office and the man alive to his own interests will do well if he will make a selection from a railroad freight office instead of hiring school graduates.

Friction of Lineshaft Bearings

SYNOPSIS—Results of an extended series of tests to determine the friction of babbitt, roller and ball bearings under different speeds, loads and temperatures.

In a paper read before the American Society of Mechanical Engineers, by Carl C. Thomas, E. R. Maurer and L. E. A. Kelso, some interesting data were given on the absolute and relative power required to drive a specially constructed series of shafts, flexibly connected and carrying loads uniformly distributed, when the shafts were supported successively by 20 ring-oiled babbitt bearings, then by 20 roller bearings, and finally by 20 ball bearings. Wide ranges of loads and speeds were covered and the coefficients of friction were worked out for each type of bearing.

The apparatus, which was designed and built in the department of steam and gas engineering at the University of Wisconsin, consisted of 25 ft. 10 in. of line-shafting in five equal sections, mounted in hangers which were inverted and used as floor stands. The hangers were bolted to two 8-in. I-beams which were leveled on the floor, and the shafts were of cold-rolled steel, $2\frac{7}{16}$ in. in diameter. Each section was 5 ft. 2 in. long; the adjacent sections were coupled together by means of a flexible leather disk or two straps connecting the two flange couplings. The flexible couplings prevented transmitting any part of the load applied on one shaft to either adjoining section and binding between shafts and bearings due to possible lack of alignment. A direct-current Fort Wayne motor was directly connected to one end of the shafting by means of a flexible coupling.

The three kinds of bearings tested were the Hess-Bright ball bearing, the ring-oiled babbitt bearing made by the Dodge Manufacturing Co. and the Hyatt roller bearing. All bearings were for the same size of shaft, and the same pieces of shafting were used for all the tests. The babbitt bearing was $9\frac{21}{32}$ in. long and its projected area 22.36 sq.in. Each roller bearing contained six right-hand and six left-hand rollers 0.78 in. in diameter; six were $9\frac{9}{16}$ in. and six were $9\frac{3}{16}$ in. long. The bearings were of the type in which a cage is used for holding one-half the rollers. Each ball bearing contained a single set of balls $\frac{9}{16}$ in. in diameter. The diameter of the inner race through the bail groove was 3.4729 in.

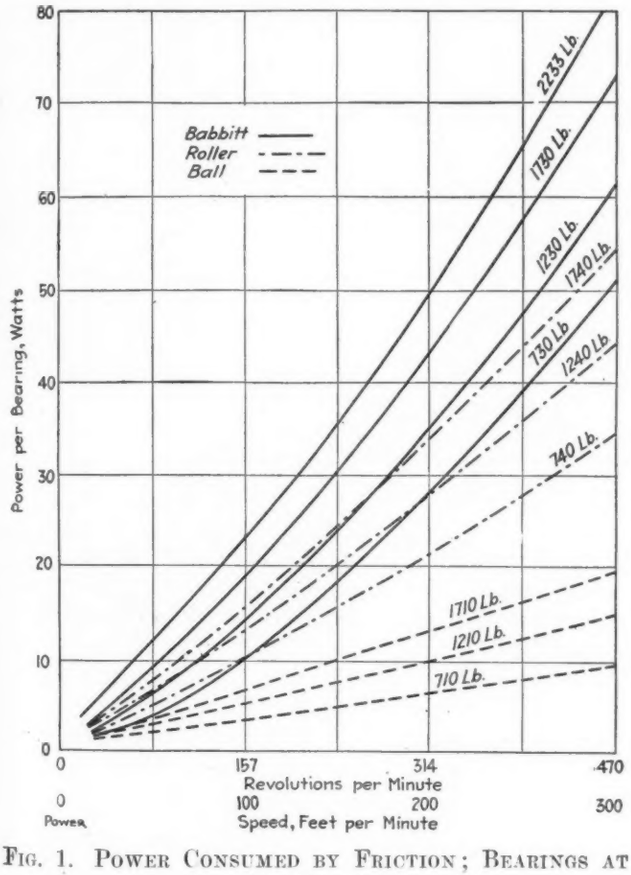


FIG. 1. POWER CONSUMED BY FRICTION; BEARINGS AT 100 DEG. F.

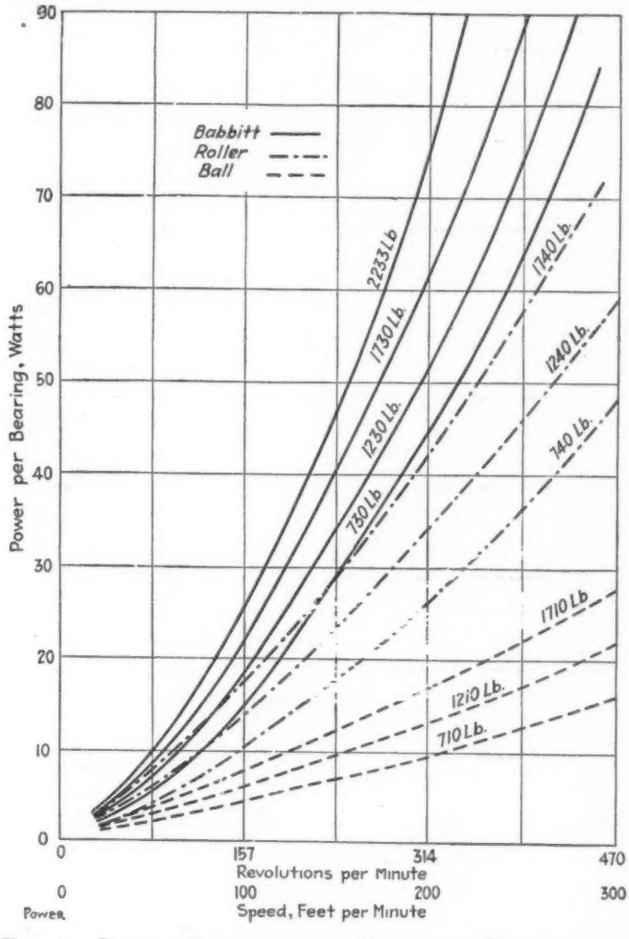


FIG. 2. POWER CONSUMED BY FRICTION; BEARINGS AT 77 DEG. F.

In the tests the speeds were between 150 and 450 r.p.m., corresponding respectively to about 100 and 300 ft. per min. peripheral speed. Most of the loads were between 700 and 1800 lb. per bearing, corresponding to about 30 and 80 lb. per sq.in. for the babbitt bearing.

Figs. 1 and 2 show a comparison of the babbitt, roller and ball bearings for 100 deg. and 77 deg. respectively. Each curve gives the power required per bearing to run the shaft under the load and speed indicated. Both figures show that the power for the babbitt is higher than for the other bearings except perhaps at low loads and

speed, and that the power for rollers is higher than that for balls. The excess of power for babbitt over rollers and rollers over balls increases with the increase of speed for all loads. The accompanying table shows the relative amounts of power consumed in friction by the three kinds of bearing at the speeds and temperatures indicated. The relative numbers are based in each case on the average power for three loads: 710, 1210 and 1710 lb. for balls; 740, 1240 and 1740 for rollers, and 730, 1230 and 1730 for babbitt.

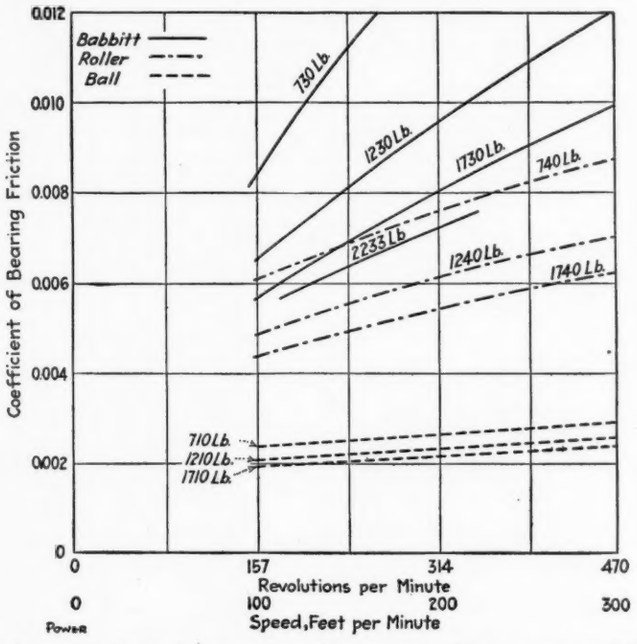


FIG. 3. COEFFICIENTS OF FRICTION; BEARINGS AT 77 DEG. F.

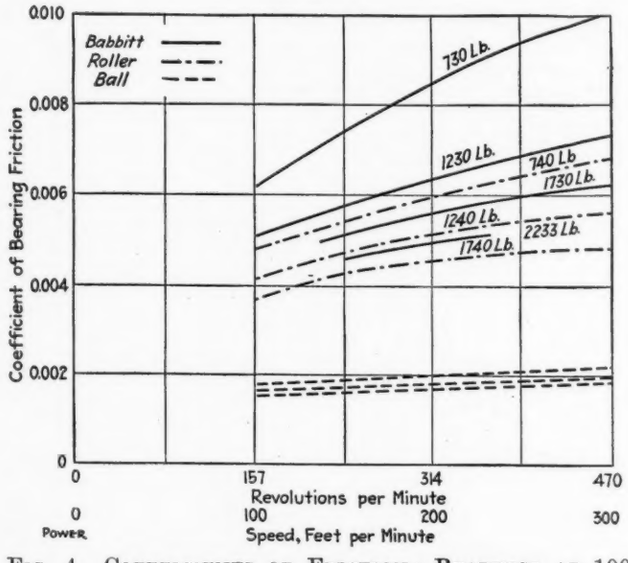


FIG. 4. COEFFICIENTS OF FRICTION; BEARINGS AT 100 DEG. F.

Figs. 3 and 4 present the comparison in another way; the ordinates are coefficients of friction instead of power as in the two preceding figures.

RELATIVE AMOUNTS OF POWER CONSUMED IN FRICTION

Bearings	100 Ft. per Min. 77 deg.	100 Ft. per Min. 100 deg.	300 Ft. per Min. 77 deg.	300 Ft. per Min. 100 deg.
Ball	1	1	1	1
Roller	2.2	2.5	2.7	3
Babbitt	3	3.6	4.5	4

A series of curves were presented to show how the coefficients for babbitt, roller and ball bearings change with the time after starting. In each case the coefficient, and hence the power, decreased rapidly at first. For the babbitt bearing there is a marked difference between the average coefficient for the first and for the second hour; this difference is less marked with the roller bearing and still less with the ball bearing.

Fig. 5 shows the rise in temperature for the different kinds of bearing under practically identical conditions. Curve *A* is for babbitt bearings under a load of 1230 lb. per bearing, curve *B* is for roller bearings under 1240 lb., curve *C* for roller bearings under 1740 lb. and curve *D* for ball bearings under 1710 lb. In the tests represented by curves *A* and *B*, the speed was 350 r.p.m., and the room temperature 80 to 81 deg.; in those resulting in curves *C* and *D* the speed was 450 r.p.m. and the room temperature 78 to 80 deg.

Breakdown tests were run on each type of bearing with only one section of shafting on which were four bearings. The maximum load was about 5000 lb. per bearing. A speed of 200 r.p.m. was chosen because it represents about the average lineshaft speed in practice. The tests began at about 3200 lb. per bearing. Failure occurred at about 4250 lb. per bearing in the case of the babbitt, 4650 lb. of the ball bearing and about 5100 lb. of the roller bearing. The bearings did not fail structurally as the power was cut off soon after distress was manifested, but the failure was simply that of the lubricant. The authors also told how the methods of testing were developed and in an appendix gave diagrams of motor losses and graphical logs of tests.

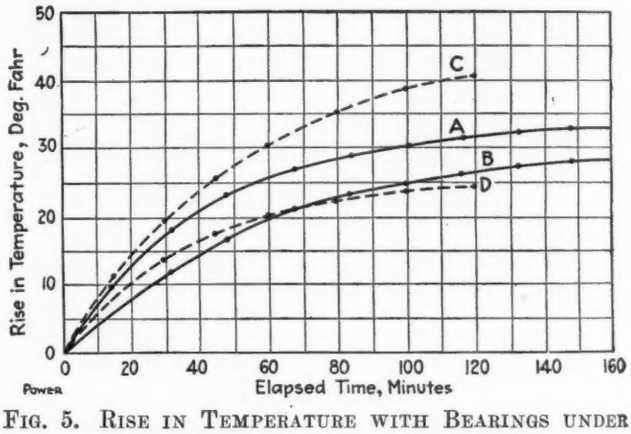


FIG. 5. RISE IN TEMPERATURE WITH BEARINGS UNDER PRACTICALLY IDENTICAL CONDITIONS

Turbine Blade Vibration — An interesting statement is made that the low-pressure blades of one of the first large turbines built failed apparently because the natural period of vibration coincided with the half period of revolution and resonance ensued. This was stopped permanently by soft soldering an additional lacing wire to the blades at half height.

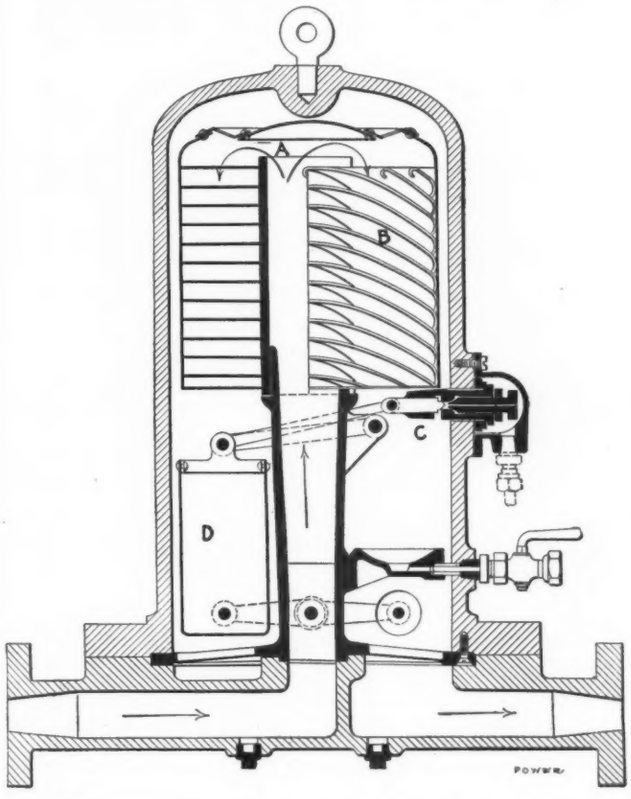
The Cost of Unloading Coal from vessels into elevated coal bunkers or storage piles has been reduced by the New York Edison Co., in New York City, from more than 25c. per ton originally to a present cost of not more than 2c. per ton, where trimming in the pile or bunker may be left out of the question. This, according to George A. Orrok, in a paper read before the American Society of Mechanical Engineers, is the result of an extensive study of the question of coal handling on piers and involves mechanical handing equipment properly designed for this purpose.

"Airex" Automatic Feed-Water Air Extractor

This device is designed to be installed in the boiler feed-line to eliminate air from the feed water. Water contains about 2 per cent. of air, which is carried to the boilers with the water and is contained in the steam leaving the boilers.

To facilitate the air extraction, the apparatus is installed near the boiler in the hot feed-water line, as hot water gives up the air easier than the cold water.

By eliminating the air, corrosion of the boiler tubes is prevented, involving less repair cost and fewer shutdowns. Another advantage of the apparatus is that less



SECTION THROUGH "AIREX" AIR EXTRACTOR

air reaches the condenser and a higher vacuum will result. The increase of the vacuum, however, cannot be given in exact figures, as the conditions vary largely.

The automatic float valve, with which the air extractor is fitted, is placed so far below the highest point in the air vessel that when starting with atmospheric air in the air vessel and a leaky valve, the surface necessary for eliminating the air is not diminished. For this purpose, and also for removing the air as completely as possible, the feed water enters the apparatus at the highest point *A* of the air vessel, at a low velocity, and spreads in a thin film over the distributing surfaces *B*.

The discharge of the water into the distributing surfaces is placed so high above the air valve *C* that there are sufficient surfaces exposed for eliminating the air.

Air, gradually collecting in the air chamber, under a pressure equal to that in the boiler, causes the water level to sink until the float *D*, acting on the air valve *C* through suitable levers, opens the air valve and relieves the chamber of air. As the float is of the open type, it is not subjected to external pressure. It is so arranged that the valve only opens when the water level has sunk about 4 in. below the air valve. This arrangement prevents dirt and oil from clogging the air valve.

When the apparatus, which is manufactured by the General Condenser Co., 1239-1257 North Twelfth St., Philadelphia, Penn., is in continuous use the water level will automatically remain at a constant height. By a special arrangement the oil and floating dirt can be drawn off.

Steam Railway Electrification*

Power companies are interested in electrification because they have electrical energy for sale. The railway companies can build and operate their own power plants, but in many cases they find it cheaper to buy energy than to generate it, the low ratio of average demand to maximum demand, making a railway load alone, rather unprofitable for a power station.

SYSTEMS OF ELECTRIFICATION

As far as the power station and transmission lines are concerned, nearly all systems of electric traction are similar, consisting generally of three-phase power generation and high voltage and three-phase transmission. It is in the motive power equipment and the distribution systems that the differences come. Four systems are finding practical application today.

DIRECT-CURRENT SYSTEM—In this system direct-current series motors are used on the locomotives or motor cars and voltages ranging from 600 to 2400 volts are used on the trolley or third rail. The trolley or third rail and its feeders receive direct-current energy from substations located at intervals along the right of way. In the substations, transformers and rotary converters change the high-voltage three-phase currents of the transmission system to direct current at the proper trolley voltage. This is the well known system used on street railways, modified to meet the demands of steam line traffic and up to the present time has found wider application in this country than all of the other systems put together. Of interest in connection with this system is the recent announcement that the Chicago, Milwaukee & Puget Sound Ry. has decided to use it in its electrification over the Rocky Mountains.

SINGLE-PHASE SYSTEM—Either series or modified repulsion type, single-phase motors are used on the locomotives or motor cars. The trolley receives its single-phase current supply from transformers, located at intervals along the line, which transform the high voltage of the transmission system to a value suitable for the trolley. Trolley voltages range from 3300 to 25,000 volts, 11,000 volts being common in this country. A balanced three-phase load is approximately secured by dividing the trolley line into sections and feeding the different sections from different phases. Transformers on the locomotives or motor cars step the trolley voltage down to a value suitable for the motors. The motors are rather complicated and have high maintenance charges. On account of the high trolley voltages used, the first cost and line losses of the distribution system are low. The most prominent example of this system, in this country, is that of the New York, New Haven & Hartford Ry.

THREE-PHASE SYSTEM—In this system three-phase induction motors are used on the locomotives and two trolley wires are required, the track forming the third leg of the three-phase circuit. Trolley voltages up to 11,000 volts have been used. Transformers on the locomotives step the trolley voltage down to a value suitable for the motors.

The two trolley wires required complicate the overhead work, but the motors are simple and rugged. The system is readily adapted itself to regenerative control of trains on down grades. The motor is inherently a constant speed motor and will carry its load up grade approximately as fast as it will carry it down grade or on the level. With some modifications in the design of the motor, its speed can be varied in steps without seriously affecting its efficiency.

The Great Northern's Cascade Tunnel electrification is the only example of this system in this country although locomotives having an aggregate rating of about 200,000 hp. are in use in Europe.

SPLIT-PHASE SYSTEM—The locomotives are equipped with polyphase motors and single-phase current is supplied

*Excerpts from a paper by Prof. D. D. Ewing delivered before a recent meeting of the Indiana Engineering Society.

from the trolley. A phase converter on the locomotive converts the single-phase energy to the polyphase energy required by the motors. The distribution system is the same as with the single-phase system, and the motive power equipment is the same as with the three-phase system with the exception of the phase converter. In a measure the good points of both systems are combined. The system is a new one and is possibly the most spectacular development in electric traction made during the year just passed.

ADVANTAGES AND DISADVANTAGES OF ELECTRIC TRACTION

The following are a few of the more important advantages and disadvantages of electric traction for railway trains. Briefly, the advantages are:

The safety of operation is increased because signals are not obscured by smoke and steam, and the locomotive driver can give his entire attention to driving and his seat can be located so that he can see both sides of the track at all times.

Regenerative control is possible with all systems of electric traction. With regenerative control the air brakes are used only in stopping or in case of emergency. Car wheels and brake shoes are not heated by long continued applications of the brakes on down grades and the number of wrecks due to cracked wheels is lessened. The energy that would otherwise be used up in heating the brake shoes and wheels is pumped back into the line and helps pull some other train up hill. While regenerative control is possible with all systems, it has not been used on all systems in the past on account of the resulting complication in the control apparatus and motor windings of series type motors.

The dispatcher can stop a train at any time by ordering the power supply shut off from the section in which the train is running and the control mechanism may be readily arranged so that the brakes are applied automatically if the power is shut off from the trolley.

In mountain grade work, higher speeds may be maintained over the grades than is possible with steam locomotives. Going upgrade the speed of the steam locomotive is limited because its power output is limited by the boiler capacity. The electric locomotive is not limited in this way and for short intervals it can carry large overloads.

Powerful motors can be mounted on comparatively light locomotives. While the weight of a locomotive fixes the drawbar pull at starting, its horsepower capacity fixes the pull when running at a given speed. This means that electrically operated trains can be accelerated at much higher rates than steam trains and can be operated at higher speeds over grades.

Electric locomotives require inspection once in from 1200 to 2500 miles of operation. To keep steam locomotives in similar condition they must be inspected and cleaned at the end of every run. On those roads which are operating electric locomotives, the daily mileage of the locomotives is from 25 to 50 per cent. greater than the steam locomotives which they replaced, and their reliability is indicated by the fact that the delays chargeable to motive power are less than 50 per cent. as compared with steam motive power.

Experience has shown that the fuel cost with electric operation is from 40 to 75 per cent. of that with steam operation. There are no standby losses. Prof. Goss has estimated that one-fifth of the coal burned under locomotive boilers is burned while the locomotives are standing on sidings, or in starting fires.

The first cost of electrification is high as compared with the first cost of steam motive power. The cost of steam motive power for the average steam road is about $2000 per mile of single track, while the cost of electric motive power runs from $7000 to $12,000 per mile of single track. The cost of terminal electrifications may be even higher.

Power house accident might put a whole railway system out of commission. The dependence of the electric locomotive on the power house tends to make it inflexible in some respects.

Steam locomotives have passed through the development stage and are practically a standard product. They have developed to their present perfection through a period covering nearly a century. They are reliable and remarkably efficient, considering the conditions under which they operate, and their characteristics and limitations are well understood by a majority of the operating men. On the other hand, electric traction as applied to railway trains is scarcely two decades old. Progress in the electric arts has been so rapid during the past quarter of a century that apparatus which today represents best modern practice is likely to be on the scrap heap tomorrow, not because it is worn out, but because it is obsolete.

Long continued overloads overheat and burn out the electrical equipment. Such overloads are common in railway service and do not seriously injure a steam locomotive. If the overload on a steam locomotive is too great, it simply stops work, and no serious injury results.

As the rails are used as part of of the main power circuit, the signal circuits for electric block signals and for interlocking plants are more complicated and expensive to maintain.

While no trainmen within the motor cars or locomotives have been killed or seriously injured, there have been a few fatalities among the men employed outside.

The losses, in a poorly designed transmission and distribution, may amount to as much as the power actually used to operate the trains.

In general it may be said that no one system of electric traction is best adapted to all classes of service. The direct current system seems best adapted to terminal work where a large number of trains are operated and where, on account of the large number of stops per mile, rapid accelerations are necessary. On account of the denseness of the traffic the substations may economically be placed close together, and as the distances are short, transmission losses are low. As far as fulfilling the general requirements of railway service is concerned, the series direct-current motor is the best motor available. But its use is limited because it cannot be operated at high voltages; low voltages on the trolley mean high line losses. Likewise, the alternating-current systems with their high trolley voltages and low line losses, and motors which lack the powerful starting torque of the direct-current series motor, seem best adapted to long trunk-line service where the stops are few and the accelerating period is short as compared with the total time of the run.

The Roanoke Dam Bill

A tilt between Gifford Pinchot and Secretary of War Garrison recently led to the withdrawal by the latter of his approval of the Roanoke River Dam Bill, introduced by Senator Martin of Virginia, and the announcement of what is to be the administration policy as to the damming of navigable streams and the granting of franchises to hydro-electric power companies.

The Roanoke Dam bill had been reported to the Senate, and would probably have come up for consideration within a few days, when Mr. Pinchot, as president of the National Conservation Association, issued a public statement declaring the measure to be the most serious blow yet struck at the conservation policy. Under date of Jan. 17, Secretary Garrison had written a letter to the Senate committee giving unqualified approval of the bill.

"The Roanoke River dam bill," said Mr. Pinchot in his statement, "makes no provision for payment to the public in return for the great values it turns over to private hands. It provides no safeguards against either monopoly or extortionate charges to the consumer. On the contrary, it is in entire accord with the demands of the water power men who were so overwhelmingly defeated at the recent National Conservation Congress. The bill embodies exactly what the water power interests have been contending for ever since a halt was called upon giving away public water powers on navigable streams by the presidential veto of the James River bill in 1909. Most of the reasons which led to this veto, and all of the reasons which moved President Taft to veto the Coosa River dam bill, are effective against this bill. The passage of the Roanoke River bill would clear the way for the enactment of the indefensible Coosa River bill itself. In addition, 17 other similar bills have already been introduced and are awaiting the result of action upon this one. To enact it would be a needless surrender to special interests at a time when the water power fight is practically won."

This statement brought from Secretary Garrison a prompt repudiation of the letter in which he had given endorsement to the Roanoke River bill. He announced that he agreed with Mr. Pinchot in his estimate of the measure, and had signed the letter of approval perfunctorily, without realizing its real import.

This incident provoked so much discussion that a Cabinet meeting on the following day was devoted to threshing out the water power and dam question. Serious differences of opinion were discovered among the President and the Cabinet on the subject, mainly as to whether the Federal government should regulate and control all power sites and plants in navigable streams, or whether the claims of the state governments to recognition in this respect should be conceded. A policy was finally agreed upon, in which an effort is made to

recognize so-called "states rights," and at the same time assert Federal rights and authority over dams and dam sites.

A bill announced to embody the ideas of the President has been sent to Congress, and will form the basis for consideration by the sub-committee on dams recently appointed by the House Committee on Interstate Commerce. This bill was accompanied by a letter from Secretary Garrison explaining the policy of the administration, which, despite the explanation, still remains a trifle hazy, as its main effort is to draw a line in what President Roosevelt called "the twilight zone" between Federal and states authority.

The proposed general dam bill is to apply only to dams and power plants built along navigable rivers within states, or between states. It does not affect the granting of power sites in the public domain. Secretary Lane, of the Department of the Interior, has announced his belief that power plants in the public domain should be built by the government itself, and until public sentiment is ready for such a course, he wants grants made under which the plants will revert to public ownership after a term of 20 years or less.

Under the proposed general dam bill, it is suggested that dam sites and franchises shall be granted only to properly incorporated utilities corporations, which must first obtain consent from the states in which the dam sites are located, and afterward obtain the consent of Congress. Such grants are to be made only in states which have laws for the regulation of utilities and their charges and operations, including the regulation of rates. Where these conditions are complied with, the Secretary of War may issue a permit for the damming of a stream, the grant to be for not longer than 50 years. Both the War Department and the Congress retain authority to regulate such operations of the dam company as may affect the navigation or navigability of the stream. The bill also proposes that where the government has built navigation dams at which hydro-electric power may be incidentally developed, the Secretary of War shall have authority to permit the use and development of this power by public utility corporations under state incorporation and regulation.

As to what restrictions, if any, shall be placed by Congress upon the regulation of dam companies by the states in which they operate, the bill has no provisions. In his letter, Mr. Garrison said that there were so many opinions as to this phase of the matter that he left the matter for Congress to determine. In his opinion, the states should derive some revenue from dams and power plants so built, and he offers, as optional plans, that the states may be allowed to tax the plants, or otherwise provide that the plants shall become the property of the state in which they are built, at the end of a specified period.

The general dam bill is reasonably certain to provoke a controversy between the states-rights advocates and the group of conservationists headed by Mr. Pinchot, who believe that the Federal Government has and should retain complete control over all dams built in navigable streams.

New York Boiler Inspectors Dine

About 200 members and guests of the New York Association of the American Institute of Steam Boiler Inspectors enjoyed the third annual banquet of the association at the Fifth Avenue Restaurant, New York City, Saturday evening, Feb. 21. The following officers were installed: President, James Gillespie; vice-president, Robert Thomson; secretary, J. H. Pollard; treasurer, George Turnbull; James H. Kinkead is chairman of the executive committee.

Mr. Young, president of the Boston Association, said that the Board of Boiler Rules of Massachusetts had requested his association to comment on the proposed rules of the board. The request was granted and the comments and recommendations of the inspectors gladly accepted. Michael Fogarty, in speaking of a comprehensive boiler law for New York state, said that the legislative committee which the inspectors met at Albany consisted of nine lawyers, a couple of storekeepers, a saloon keeper, etc.—a 57 variety kind.

Mr. Brown, secretary of the new Buffalo association, reported the progress made by the inspectors in Buffalo. Mr. Van Winkle, of the Travelers Indemnity Co., told of the pensioning of old inspectors by his company. He stated that one need not fear that state boiler laws would eliminate the insurance company's inspectors.

F. R. Low, editor of "Power," reviewed the progress of the uniform boiler laws committees of various engineering organizations. He also quoted interesting figures on the life of steam boilers in Switzerland. Some of these boilers are over 60 years old and are still giving service under reasonably high pressure.

Mr. Hansen, secretary of the Workman's Compensation. Commission of New York, spoke interestingly on the amount collectible by those injured and by beneficiaries of those killed in boiler explosions now that the workman's compensation law is soon to be enforced in New York State. In 40 years over 10,000 persons have been killed in boiler explosions in the United States. Under the workman's compensation law this would represent about $50,000,000 in damages for those killed. The fact that only one boiler in ten of those exploded was inspected by insurance companies demonstrates the value of systematic inspection.

Mr. Hansen stated that although there were fewer boiler explosions in Europe, America was first to propose comprehensive boiler rules, for he remembers when the rules chiefly used in Europe were those formulated by the Hartford Steam Boiler Inspection & Insurance Co. State boiler inspection has many virtues, but to be of real value it must always be independent of politics.

Other speakers were Messrs. Idel, Banks and James White.

Mr. Thompson, the retiring president, was presented a beautiful silver-mounted, stag-handled umbrella. A feature of the speaker's table was a full-equipped model of a Babcock & Wilcox single-drum boiler.

Electric Veterans Organize

On Saturday evening, Feb. 21, the employees of the Westinghouse Electric & Manufacturing Co. who have been with it for 20 years or more, held a meeting and organized the Veteran Employees Association of the Westinghouse Electric & Manufacturing Co. A business meeting was held and officers were elected for the ensuing year. Following a dinner was an interesting program consisting of speeches and vaudeville. The toastmaster was L. A. Osborn, vice-president of the company. A striking fact was the youthful appearance of these so called veterans, the majority appearing to be men in the prime of life.

About 325 employees are eligible to membership, and approximately 315 were present at this meeting. President Herr, in the course of his remarks, promised the support of the company to the organization, and stated that the officials were working on pension plans for the employees, details of which will be announced later. Other speakers were: Chas. A. Terry, vice-president; and James J. Barrett, representing the shop. Mr. Terry gave several interesting reminiscences of the developments which have occurred during his experience of over a quarter of a century with the company.

Guy E. Tripp, chairman of the board of directors, was present and was elected an honorary member, as was President Herr, neither having been connected with the company the required 20 years. A standing toast was drunk to George Westinghouse, who was unable to be present on account of illness.

NEW PUBLICATIONS

FACTORY ORGANIZATION AND ADMINISTRATION. By Hugo Diemer. Second edition; 378 6x9-in. pages; 174 illustrations. Bibliography; indexed; cloth bound. Price, $3. McGraw-Hill Book Co., New York City.

This second edition of a well received book on industrial management contains some 70 pages more than in the first printing. In the work of enlarging, the volume has been, to a large extent, rewritten and extensively rearranged, to bring about a more logical sequence. This has been necessitated by the important development in industrial management, since the book was first issued. The paragraphs are now numbered and are given topical headings. At the end of most of the chapters is a reference to specific chapters or sections of modern books, the transactions of engineering societies and articles that have appeared in the technical press. These changes will make it more useful and of more help to anyone who wishes to pursue the study of the subject further.

Bagged Boiler Photographs—For use in educational work, W. V. Ford, 1046 East 79th St., Cleveland, Ohio, is desirous of securing good photographs of boilers and boiler tubes that have been bagged from deposits of oil on the tubes and shell, and will gladly pay well for any that are sent him which may prove suitable for his use.

Winnipeg Hydro-Electric Developments

The J. G. White Engineering Corporation, New York, has been engaged by the Winnipeg Electric Ry. to complete surveys, explorations, designs, plans and estimates for a large hydro-electric development near Winnipeg, Canada. It is understood that the ultimate development will considerably exceed 100,000 hp., and that the immediate development, for which complete designs and plans are to be prepared, will be for 40,000 hp. Work on the surveys, explorations and designs is to be started immediately and completed as rapidly as possible.

The Winnipeg Electric Ry. Co. was formed by a consolidation of the Winnipeg Electric Street Ry. Co. and the Winnipeg General Power Co. The outstanding capital stock is $9,000,000. The directors include Sir William Mackenzie, who is president and a large owner, as well as well known citizens of Winnipeg, including William Whyte, vice-president, and F. M. Morse, secretary and treasurer. The directors include also H. S. Sutherland, Winnipeg, Sir William Van Horn, Montreal, and Sir Donald Mann, Toronto.

It is understood that there was considerable competition for the work just awarded, and that this was finally given to the J. G. White Engineering Corporation because the directors were convinced that this corporation had an exceptionally experienced staff of engineers and construction superintendents for handling this class of work, and the preliminary designs submitted appealed to the directors as suggesting the most advantageous plan for developing the enormous water power.

Civil-Service Opportunities

COMPETITIVE EXAMINATIONS *for the civil-service positions named below will be held on the dates given. Applications and further information may be had by addressing the respective commissions. Candidates must be citizens of the United States and residents of the cities in question, and at least 21 years of age, unless otherwise specified.*

Situation for Gas Engineer—The Philadelphia Civil Service Commission will hold an examination, Mar. 21, for the position of gas engineer in the Bureau of Surveys, Department of Works. Salary, $1000 per year. Address the Civil Service Commission, Room 875, City Hall, Philadelphia, Penn.

Situation for Engineers—The Philadelphia Civil Service Commission will hold examinations, Mar. 21, for three positions of power-plant or stationary engineer. Salaries, $1500 to $1800; less than $900, and $900 to $1200 per year. Address the Civil Service Commission, Room 875, City Hall, Philadelphia, Penn.

Situation for Engineer—The Philadelphia Civil Service Commission will hold an examination, Mar. 27, for the position of engineer in charge of boilers in the Water Bureau of the Department of Public Works. Salary, $1500 per year. Address the Civil Service Commission, Room 875, City Hall, Philadelphia, Penn.

Situation for Engineer—The Philadelphia Civil Service Commission will hold an examination, Mar. 21, for the position of operating engineer in the Water Bureau of the Department of Public Works. Salary, $1000 per year. Address the Civil Service Commission, Room 875, City Hall, Philadelphia, Penn.

SOCIETY NOTES

The proposed consolidation of the engineering courses in the University of Pittsburgh and the Carnegie Institute of Technology was discussed informally during the recent visit to the city of Dr. Richard C. Maclaurin, president of the Massachusetts Institute of Technology. No definite action was taken. As Dr. S. B. McCormick, chancellor of the University of Pittsburgh, is abroad it was impossible to get an expression from the authorized representatives of the two institutions. Dr. Maclaurin declared that he came to Pittsburgh to attend an alumni reunion of Massachusetts Tech and would not venture an opinion as to the feasibility of a union of the two schools similar to the consolidation of the Massachusetts Institute of Technology and the engineering department of Harvard University.

On Tuesday evening, Feb. 17, Illinois Association No. 1 of Chicago was visited by the officers and trustees of the National Association of Stationary Engineers. The officers on the night of the meeting had just returned from Milwaukee, where they had met and conferred with the national convention committee on the arrangements for the next annual convention in September. At the preliminary business session Jacob Reitz presented President Hays a handsome cut glass punch-bowl set, a wedding present from his brothers of the order. At the close of the business session the doors were thrown open and the meeting turned over to Past President John F. McGrath. H. Misostow introduced the speakers of the evening. National President, James R. Coe, gave a long address on the good of the order, and incidentally predicted a record-breaking convention in Milwaukee. William J. Reynolds, trustee, gave some statistics on "The National Engineer," and the convention was again touched upon in short addresses by the president and secretary of the National Exhibitors Association. W. L. Parker, Elgin, Ill., extended a royal welcome to the national officers. Alfred Johnson spoke briefly on the educational work of the association, and Past President McGrath gave the closing talk of the evening.

Dr. W. M. Davidson, superintendent of public schools of Pittsburgh, told the Pittsburgh section of the American Institute of Electrical Engineers at the Fort Pitt Hotel, Feb. 14, that he represented the American Educational Engineers, Pittsburgh branch. He asked for the sympathetic coöperation and generous support of the electrical engineers in the educational work of Pittsburgh and said that the aim of those directing the Pittsburgh schools was to bring them to a degree of efficiency not equaled by any others. Paul M. Lincoln, of the Westinghouse Electric & Mfg. Co., dealing with the cost of electric service, said that there was much misconception concerning rates; that the cost of electricity to the public is fixed by the cost of the service added to a legitimate profit. He said it was easier to supply a small number of large consumers than a large number of small consumers, and for this reason rates for service in residences were necessarily higher than those for factories. C. O. Mailloux, of New York, president of the Institute, was the guest of honor and spoke on "The Institute." He said that the cooperation among electrical people that the institute had encouraged, was its most beneficial result. The toastmaster was Samuel M. Kintner, vice-president and general manager of the National Electrical Signaling Co., who is engaged in wireless telegraphing work with Prof. F. A. Fessenden. George P. Early, of the American Sheet & Tinplate company, delivered a humorous talk on "Stomatology." The banquet was attended by 300 members.

OBITUARY

EDWIN M. HALL

Edwin M. Hall, treasurer of the Jefferson Union Co., Lexington, Mass., died on Wednesday, Feb. 11.

EUGENE McSWEENEY

Eugene McSweeney, president of the United States Graphite Co., Saginaw, Mich., died at Hot Springs, Ark., on Mar. 1.

Mr. McSweeney was born in Kalamazoo 46 years ago, and started his career selling newspapers. His life had many hard setbacks, but he fought the uphill battle until he reached the top. At his death he had been not only successful as a newspaper publisher, but made a thriving venture of the United States Graphite Co.

Mr. McSweeney entered the newspaper field in Kalamazoo. When of age he became identified with the "Kalamazoo Gazette." In 1891 he came to Saginaw on the old "Evening News." After a short time he returned to Kalamazoo, and six months later came to Saginaw and became treasurer and general manager of the paper, and part owner with John T. Winship, now state insurance commissioner.

Messrs. McSweeney and Winship conducted the paper on a successful scale, building it from a meager to a prosperous institution. In 1910 the paper was sold to the present owners. Four years previous Mr. McSweeney had given up active management of the paper, becoming president of the United States Graphite Co. Today the company is the largest of its kind in the world.

Mr. McSweeney was active in civic life. He served as president of the Board of Trade, the Saginaw Club, and was identified with several manufacturing institutions.

Charity was one of the big sides of Eugene McSweeney. While unostentatious, his alms reached scores of needy. His heart was big and he gave with a free hand. He leaves a widow and two children, Eugene and Hanna.